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EDITORIAL

AT last we know the underlying causes for the slides in the Panama canal. A noted scientist has ascribed the trouble to "supersaturated soil slipping through unstable equilibrium to ultimate stability, transmitting the strain to weak underlying strata as it travels." How simple it all is when one really understands it.

COMMENT has appeared before in these columns concerning the many schemes that have been proposed for the preservation of the Exposition buildings. Many of these were fantastic in the extreme, while the latest concerning the California building is thoroughly worthless. It has been suggested that this building be used for a Normal school. For many years, all new buildings for the State Normal schools have been of fire-resisting construction. To accept this flimsy shell for housing students seems utterly preposterous. We do not believe that this idea will be taken seriously.

THE San Diego city fathers seem determined to leave no stone unturned to secure every available water supply. They have commenced a contest with the Cuyamaca Water Company before the Federal Land Office for a dam-site and right-of-way for a pipe-line, the possession of which will enable the city to double its present supply. In the meantime, the city has contracted with Mr. C. M. Hatfield, rain-maker, water-witch, and all around medicine-man, whereby the latter is to fill the existing reservoirs on the money-back, no-cure-no-pay system. If the heavenly plumbing should prove to be in a bad state of repair this winter, and the gentle rains should fill the reservoir, will the city auditor of San Diego approve Mr. Hatfield's pay warrant?

SOME months ago we commented on the fact that, by the annexation of the San Fernando valley, the city of Los Angeles became the second city in the United States in point of area. Some Argus-eyed official must have seen the article, for it appears that Mr. Homer Hamlin, city engineer, has made a rough computation which has led him to believe that the area of the city is already actually greater than that of New York. He has therefore requested that an appropriation be made to purchase surveying instruments and an automobile, which, properly co-ordinated, should enable him to prove that Los Angeles is the greatest city in the United States.

CENTRALIZED control of county highways is being adopted in California to an increased extent. In both San Joaquin and Los Angeles counties the completed highway systems are under the supervision of county engineers. Kings county supervisors have turned over the administration of all county roads, except their new highway system, to a road overseer. Unfortunately, the Board has selected a former sheriff of the county to fill this important position. Without in the least impugning the motives of the Board, or reflecting upon the ex-sheriff personally, we believe the choice to be a mistaken one. Highway engineering is a profession and skillful supervision, maintenance, and up-keep of highways is but a few degrees less important than the operation of a railroad. None other than a trained man should be employed for such duties. An interesting apology of the left-hand variety is found in the fact that the new county highway system now under construction has been excluded from the jurisdiction of the newly-appointed road overseer. Perhaps the Kings county board makes a distinction between good new roads and old bad roads, and regards the supervision of the latter as an expense rather than an investment. It is not inappropriate to point out, however, that bad roads may be made better, if not altogether good, through skillful maintenance and up-keep methods. It would be hardly reasonable to expect any other than a trained highway engineer to accomplish such results.

'Home Industry' and the Award of Contracts

How far the practical operation of the great American policy of protection to home industry should be extended, is an open question. Unfortunately, the tariff for years has been treated as the football of partisan politics rather than a question of economics, for which the solution can only be found through careful study by a board of experts. Following the example of the National Government, protection for home industry has been directly or indirectly extended so that we hear frequently of one state protesting against the purchase of material that is made in other states. More than that, the same policy is more or less in vogue in the counties, cities, and towns within the states. The extension appears perilously like the *reductio ad absurdum* solution of the problems in geometry in our high-school days. California is known as a hotbed of the doctrine of fostering home industry, not merely in the purchase of material but in the hiring of men, the 'Native Son' element in the latter case constituting the domestic labor-market. A short time ago bids were opened for the construction of a school-house at Richmond, California. A contractor who was so unfortunate as to dwell without the city limits of Richmond was the lowest bidder. The school board, as a compromise

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measure salving their home-industry conscience, proposed to award the contract to him if he would agree to employ only local labor. Local labor in this case being probably more expensive than that upon which the contractor had figured, he was of necessity compelled to reject the offer. The contract therefore was let to a higher bidder.

We have no quarrel with the home-industry sentiment; as a matter of fact, it is not only good politics but good economics in many cases. Obviously, a community to be self-contained and self-supporting should as nearly as possible spend its money for the support of local enterprises. There is, however, a reasonable limit beyond which it is neither good business nor good sense to go. Every part of the United States possesses certain natural resources that give it an advantage over other sections, and at the same time certain disadvantages. It would be absurd, for instance, for the State of California to promulgate a doctrine for the use of no hard coal within the State other than a local product, for the obvious reason that there is no such local product. There are certain commodities that are produced to a limited extent in California, and which are produced better and at a lower figure elsewhere. It would appear to be the part of good sense to adopt, at least, some sort of a compromise measure whereby a differential in favor of Californian products expressed in terms of percentage could be adopted in order to protect our infant industries until they have become old enough to vote. If the policy of protection is pursued indiscriminately, however, reprisals by other sections of the country would follow as a natural sequence. It would be interesting if, in response to a local embargo against steel products produced in Pittsburg, a similar course of action should be taken by the smoky city against Californian oranges. Fostering home industry is an excellent thing, but as a sword it is two-edged and is prone to cut both ways.

Regulation by Importunity

Perhaps some of our readers who are not too old to have forgotten may recall a biblical parable concerning a judge who granted the request of a widow who came before him "because of her importunity." It is a far cry from the court-rooms of ancient Syria to the offices of the California Railroad Commission; nor do we think it quite fair to refer to the officials of public service corporations as widows; nowadays, unfortunately, they are more like orphans. Nevertheless, there is a certain parallel between the predicament of the judge in the Bible and that in which the Railroad Commission found itself in a number of recent cases heard before that august body.

The Pleasant Valley Water Company furnishes water to the city of Coalinga and the adjacent oilfields. The region is arid and water has to be pumped from a considerable depth and distributed through long, expensive pipe-lines. In addition, the boom days in the oilfields have probably passed, so that consumption is decreasing rather than increasing. Water rates, as a consequence, must necessarily be high if the stockholders in the utility in question are to receive any returns from their investment. Taking advantage of the opportunity afforded by the public-utility law in the State of California, the city of Coalinga applied about a year ago for a reduction of rates. The company, in its own defense, applied at the same time for an increase. The next step was a valuation of the company's property. The figure submitted by the engineer for the company was in virtual agreement with that presented by the Commission. The Commission decided that the rates in force should be continued, granting merely a slight increase in the amount paid by the city for fire protection. The company, however, was confident of the justice of its contentions and after some delay obtained a rehearing. At this rehearing, despite the fact that practically no new evidence was introduced on either side, new rates were established, which, without changing the quantity rate, reduced the amount for the minimum rate to such an extent that the Commission's engineers estimated that the returns to the company would be increased approximately 50%. This gave the company all that it had sought at the first hearing.

A similar case is that of the Palermo Land & Water Company. The original rate charged by the company for irrigation water was 12½ cents per miner's inch per day. After commencing operations, this rate proved to be unprofitable. The Commission was asked to establish a rate of 25 cents, and instead granted to the company a rate of 15 cents. A rehearing was sought by the company which was finally granted after a delay of nearly two years, and then not until the company had taken steps to carry the case to the State Supreme Court. Again in this case the testimony submitted at the rehearing was substantially the same as in the first instance, except that the expected reduction in sales of water to dredging companies, constituting the company's other principal source of revenue, had come to pass. A new rate of 22 cents per miner's inch was established.

In moralizing over the results of these two cases, the conclusion is forced that the companies in question won their contentions not by reason of the evident justice of their claims, but because they fought them to a finish. Even these victories do not carry with them complete justice, as the loss in revenue, due to transacting business for long periods at rates that were finally judicially determined to be unprofitable, is borne by the company. We hope that the time may come, and soon, when the members of the Railroad Commission will readjust their mental attitudes in cases that come before them. The spectacle of the down-trodden people has changed to the down-trodden corporations. We realize and grant the necessity for a tribunal that will view the contentions of both sides impartially and will see that each receives what is his just due. In theory the Railroad Commission is such a tribunal, not a body of advocates representing the consumers. We hope that before long this theory may be reduced to practice.

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REVIEW OF THE MONTH

HAPPY New Year to you all, readers, contributors, and advertisers who have done so much to help us to make WESTERN ENGINEERING a real factor in the engineering and contracting activities on the Pacific Coast. It is of little consequence who originated the annual custom of the exchange of Season's Greetings among friends and acquaintances. The holiday season, with its momentary relaxation from the cares and struggles incident to winning a livelihood, is the safety valve through which the accumulated pressure of self aggrandizement is permitted to escape in time to prevent the destruction of the vessel. The genial spirit, the cheery greeting combine to form one of the truly bright spots in this earthly existence. The crisp December air, the roaring fire, the holly, and that great national bird, the turkey; truly it is good to be alive.

THE best that may be said of the late, unlamented 1915 is that it is over. The War overshadows all, casting its pall of carnage and destruction everywhere. Here we are spared the visual horrors, and some of us are even profiting mightily through the complete disruption of industrial Europe. As the War shows no sign of coming to an early end, there seems every likelihood that the United States is in a fair way toward becoming not only the industrial but the financial centre of the world. Much depends upon the course of action pursued by our bankers and manufacturers during the War period, whether substantial benefits will grow out of the present state of affairs. Standards of manufacture must be rigidly maintained; the farther away from the source of supply, the more essential this becomes. Conditions in foreign markets must be studied sympathetically and understandingly; then met. American business men must learn to speak and write languages other than their own. A working knowledge of Spanish is an asset not to be disregarded, if we are to hold the South American and Mexican trade when European competition again becomes a factor in the case.

THERE are, at least, symptoms that Americans are beginning to realize these things. Even the bankers, conservative to a fault as a general rule, are beginning to establish South American branches. Credit is the keynote to the whole situation. Without it, all talk of extensions to foreign trade is a waste of words. American manufacturers have been severely criticized for insisting on immediate payment for goods sold for export, when the almost total absence of banking facilities made it a practical impossibility to extend credit. Long-time credits are the rule rather than the exception in Latin America, and this is a condition which the American banker must put the manufacturer in a position to meet. The farmer, in order to cultivate his ground must irrigate. This requires machinery and supplies. He will not be in funds until his crop has been harvested and sold. The manufacturer who is in a position to extend credit gets the order. It is the banker this time who must blaze the trail through the wilderness of export-trade extension.

AGRICULTURE and mining are the two basic industries. Europe is drawing heavily upon American ability to produce food-products, fabrics, and manufactures of metals. As a result, there is a revival of mining, especially of the base metals, that has reached the proportions of a boom. When farming and mining are prospering, so is every other walk of life, for the money wrested from Nature's storehouse finds its way into every channel of human activity. A year ago, in these columns, we referred to the condition then existent as a "buyer's market." How true that was is obvious. Metal prices are sky-high; more mines are being opened to produce more metals; more machinery is being manufactured to open more mines; more men are being employed to make more machinery, and so it goes. That 1916 will be a banner year, and 1917 still better seems assured. It is well. We can all stand a little prosperity to make up for the many lean years that have gone before.

ONE interesting exemplification of the fact that the United States has become the market place for the world is shown by the increased purchase of supplies and machinery for use in the Orient. Within the last month, engineers for great enterprises in Russia and Siberia have come to San Francisco for the purpose of purchasing apparatus costing in all nearly $1,500,000. They tell us that this is only the beginning. American manufacturers and supply-dealers will do well to consider Russia as a potential buyer of great importance. Business of this nature, to be efficiently handled necessitates the establishment of branch houses in the important centres. A knowledge of Russian is advantageous, though not absolutely essential. Look West, young man, until the West becomes the Far East. There lies the tide soon to be at the flood that leads to fortune.

MEXICAN oil companies are required to file voluminous reports with the Carranza government on or before January 15. The information required is similar to that which a company would be called upon to furnish if it desired to operate under the blue-sky law in

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California, and is apparently sought for much the same reason. Failure to file this information within the specified time will result in forfeiture of the company's rights. There are over 250 companies organized to operate in the Tampico district, but only a small number ever commenced actual operations. Many of the latter have discontinued development on account of disturbed political conditions.

REOPENING the Panama Canal seems as far away as ever. A few days ago a passage was made through the slides sufficiently large to permit the entrance of several small vessels which have been waiting at the Canal for some months. The canal was then closed to all traffic for an indefinite period. A commission of civilian geologists and engineers is now investigating conditions on behalf of the Government. However, it is doubtful if they can do more than agree with the reports of General Goethals and indorse his methods of combatting the situation. Incidentally, the interruption of traffic furnishes a fresh reason why the American people should be glad that a sea-level canal was not adopted, for, however serious the slides in the lock-canal, it is evident that they would have been far worse had it been of the sea-level type.

WESTERN railroads, in the meantime, are feeling the beneficial effects of this not entirely ill wind. Congestion at terminals is noted, not only at San Francisco but also at New Orleans and Galveston. The freight business of the Southern Pacific Company is larger than it has been in six years, and instead of many idle cars there is actually a shortage. Contributing factors to these conditions have been, of course, the abundant crops and generally improved business conditions throughout the country.

ONE of the most important links in the California state highway has been completed and opened to the public. This is the section of road between Bakersfield and Los Angeles, a distance of 124 miles. Although this road traverses a highly mountainous country, yet it appears almost as a straight line upon an ordinary scale map. When attention is directed to the fact that former routes between the same points varied between 148 to 178 miles, the excellent work of the highway's locating engineers will be apparent. Whether the completion of this section of road will result in an increase in the jitney family remains to be seen. The Southern Pacific right-of-way between these two points is 171 miles in length, made necessary on account of heavy grades and curves.

IN these columns a short time ago we had occasion to comment on what we regarded as unfair tactics pursued by a certain Californian county with respect to insisting upon the assumption of a contract by a bidder who had made a mistake in preparing his estimate. It is a pleasure to record the opposite course taken recently by the Board of Supervisors of Glenn county, California. As in the former case, the low bidders found that they had made a serious error in preparing bids for the construction of a certain bridge. They appeared before the Board and requested permission to withdraw their bid, agreeing to reimburse the county for any expense caused by their mistake. The Board saw the reason in this request and granted it. We believe that this example of fair play on the part of the officials of Glenn county will so react in their favor where future work is concerned that financially, as well as morally, the county will profit more than if the Board had insisted upon its pound of flesh.

OIL-PRODUCTION in California continues to be somewhat less than consumption. The shortage for November was about the same as for October, 1,000,000 barrels for the month. The 'shut-in' production is now estimated at about half that amount. There has been a small increase in drilling operations in consequence. The bulletins now being issued by the oil and gas supervisor show that during the four weeks ending December 18, thirty-nine new wells were started. It is significant, however, that eighteen of these wells are being drilled by one marketing company and its subsidiaries, four by another large marketing company, and three by the Kern Trading & Oil Company, which is the oil-producing department of the Southern Pacific railroad. Most of the remaining wells are being drilled by established companies whose operations have never been used as a screen for stock-gambling. There is still reason to hope for continued sanity in the oil business. For this we have to thank the blue-sky law and the general difficulty of raising capital. In any case, the outlook is favorable for an improvement in prices in the near future.

OIL-OPERATORS on unpatented land are continuing their campaign for remedial legislation with considerable vigor. The Oil Industry Association is increasing in membership and has sent a delegation East to urge action by Congress. Some measure of relief is recommended by the Secretary of the Interior in his annual report. Indeed, the greatest danger to the cause of the oil-men lies in the actions of some of its overzealous advocates. Thus one official of the Oil Industry Association is reported to have announced that he and his associates were going to Washington to demand that patents should be granted to the oil companies. Others have taken advantage of the increased price of crude oil and petroleum products, and are predicting before audiences of small consumers that the price will increase 50% at least if the affected companies are not immediately granted patents. The absurdity of this contention is demonstrated when, almost in the same breath, they show that if production on these unpatented lands ceases, the underlying oil will be drawn to wells on adjoining properties and go to swell their production. Those who have the interests of the industry at heart can only hope that these wild assertions are not brought to the attention of members of Congress, at least until a remedial bill has been passed and signed by the President.

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DISCUSSION

Concrete in Sea-Water

The Editor:

Sir—I am very much interested in the article on the use of concrete in sea-water by Mr. William Hood which appeared in your November number. I thoroughly agree with Mr. Hood that a careful selection of the materials to secure a dense rich mixture and great care in depositing the concrete are essential in order to secure satisfactory work in placing concrete under water.

One important matter which Mr. Hood has failed to mention in his article, but which he no doubt follows out in practice, is to keep the work going continuously until the surface of the concrete which is being deposited in the forms is brought above the water line. If for any reason the work of placing concrete is stopped during the operation, the inert material, known as *laitance* collects on the surface of the concrete and prevents a bond between the two sections when the work is again started. This inert material remains suspended in the water as long as the concreting is kept going continuously, but as soon as the work stops it settles on the surface under the water, with the result that there is a bad joint with no bond between the two sections.

One matter in which I do not thoroughly agree with Mr. Hood is the question of mixing the concrete "rather dry." It is difficult to say just what "rather dry" means, but I would call attention to the fact that it is essential that there should be enough water to exclude all air from the mixed concrete. If there is not enough water to force all the air out from between the particles of sand and stone, the result will be that the air will come out in the form of bubbles after the concrete has been placed under the water, the result being that the set of the cement is disturbed.

In general, as Mr. Hood states, extreme care in watching every detail of the operation is necessary to secure good work.

HARRISON W. LATTA.

San Francisco, November 20, 1915.

The Editor:

Sir—I am favored by receipt of copy of letter from Harrison W. Latta.

My letter of October 21, 1915, was not intended to be a full account of the matter. In it I mentioned our practice of conservative use of mixing water. Where we deposit concrete under water we mix it essentially as if we were to use it in the air and ram it in place. As a matter of course, we intend on starting work under water to keep the work going continuously. If, on account of any unforeseen circumstances, the placing of the concrete is stopped for any considerable period, we are accustomed to jet the surface thoroughly with a powerful jet, such as we would use in jetting piles in place, the jet being powerful enough to scour off thoroughly any *laitance*.

If the stopping of the work is at such a height that we can readily pump out the water and expose the surface, we are accustomed in addition to this to clean and roughen thoroughly the surface of the concrete already placed, and sprinkle it with neat cement immediately before placing concrete.

We have a number of experimental briquettes hardening under sea-water. The first of these will be ready for test in January.

I gave a very general idea of cement composition under sea-water in my previous letter. Our specification in the purchase of such cement is precisely as follows:

"As this cement is to be deposited in salt water, it is necessary that chemical composition of cement be low in alumina, with a maximum of silica, and, in addition to usual standard tests, this cement should conform to the following:

Alumina (Al_2O_3) from 6 to 8%.

Magnesia (MgO) not more than 2%.

Anhydrous sulphuric acid (SO_3) not more than $1\frac{3}{4}$%."

WILLIAM HOOD.

San Francisco, December 22, 1915.

Reports of Geological Survey

The Editor:

Sir—Both the article by Mr. Pepperberg on 'Discrepancies Between Map and Text in a Geological Survey Report' and your editorial in the December number of WESTERN ENGINEERING have been read with natural interest. Of the system of criticism and review of manuscripts in this Survey, Mr. Pepperberg is well aware. However, when it is remembered that the publications issued by the Survey, in the course of a year, number over 190 and that the number of different maps issued exceeds 132, I trust that both WESTERN ENGINEERING and Mr. Pepperberg will recognize that occasionally a 'break' may get through the mill.

The area covered by the report in question falls within the region given general treatment in a more comprehensive report, now in process of publication as Bulletin 629. In this report confession of sin is frankly made. The report will also contain the statement that a revision of the erroneous contouring has been published by Mr. Pepperberg in your magazine, which is cited in full.

In justice to Mr. Wegemann, the author of the faulty map, let me add that Mr. Pepperberg's surmise, that the final drafting and publication of the map may have been

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done while Mr. Wegemann was absent from Washington and engaged in field work, is quite true, Mr. Wegemann having been in Wyoming at the time the map was redrawn and passed to the printer. Further, it should be noted that Mr. Wegemann, who had returned to Washington only a few days before the receipt of your magazine, had already noticed the bad contouring before the receipt of Mr. Pepperberg's article.

GEORGE OTIS SMITH.

Washington, D. C., December 23, 1915.

Commercializing Technical Societies

The Editor:

Sir—Noting in your issue for November an editorial on 'Commercializing Technical Societies,' which has in it much of the 'Jingo' which may reasonably be expected in the daily press, makes one wonder if our technical papers are really going to start crying " 'Ware the Wolf."

While I carry no brief for the gentlemen mentioned, I know them well and favorably, and also, having some first-hand knowledge of the guiding reasons for their having presented the subjects under discussion, I take this opportunity to address you.

In 'the spirit of a square deal' it might interest you to know that the participation of Messrs. Cory and Vincent, in the preparation of the paper, 'Inventories and Appraisals of Properties,' presented at the Pacific Coast Convention of the American Institute of Electrical Engineers was at the express request of the Papers Committee of the Institute.

Should the fact that one of these gentlemen is on the staff of a public utility, and the other a consulting engineer who has from time to time been employed on special work for the same utility, incline us to believe that this utility is reaching out to seize and impress its ideas upon, or by trick and device secure the endorsement of, the American Institute of Electrical Engineers to theories that are presumably favorable to its interest and thus commercialize a National Engineering Society?

Assuming such problems are of interest to the membership of such technical societies (and I judge they are from the number of papers presented), who shall present them? Engineers who have had practical experience in their application, or some theorist who has had none?

As to the other papers mentioned as being presented by Mr. Frank G. Baum, I have read them with much interest and the fact that Mr. Baum also does some work for the same utility employing Mr. Vincent would not seem to indicate anything contrary to good engineering ethics, but rather to indicate that he too is active of mind.

Many recent papers on similar subjects have been presented to the same society by Messrs. Ferguson, Grear, Lincoln, Hamilton, and numerous others. These gentlemen are all directly connected with public utilities or manufacturing companies located in different parts of the country.

What would you have, Kind Sir; the presentation of papers to technical societies confined to college professors, consulting engineers who never work, or who, pray, who?

I do not believe we need fear any reaching out by the financial monster Commercialism to seize these our engineering societies—for after all—'what's the use?'

I will agree that the presentation of papers and original thoughts on Electric-Service Rate Making, and possibly on Valuation subjects might be of greater value to the authors and to the development of the industry if presented before such a commercial organization as the National Electric Light Association, inasmuch as they are essentially commercial subjects. Still, if the other technical societies invite their presentation, why spank the author?

In conclusion, if engineers must Stop, Look and Listen, as to what subject is before the various regulating commissions before offering new thought on such subjects for fear of being accused of seeking to influence their decisions, they will be indeed silent, for such matters are before the commissions all the time.

W. W. BRIGGS.

San Francisco, December 27, 1915.

[Mr. Briggs presents his views in characteristic breezy fashion. He affects to be unable to see our point of view. We intend neither to "spank the author," nor to deny "the right of public utilities to present arguments with a view to influencing the authorities—railroad commissions, for example;" but we do intend to protest whenever, "engineers known to be on the staffs of important public corporations * * * present before national engineering societies papers dealing with rates and appraisals in such a manner, perhaps inadvertently, as to attract the attention of railroad commissions to those papers to a degree that might be construed as referring to matters then pending;" and to invite some thoughtful consideration of, "the grave misunderstandings that would ensue * * * if the incident should prove to be one of a series and likely to establish a precedent."

If it is a fact that Mr. Baum's paper was really intended for the July Convention, and was hurried into publication in January, just before the Railroad Commission handed down its decision on the San Jose rate cases, and if it is a fact that the public utility known to employ Messrs. Baum, Cory, and Vincent, caused, or sought to cause, special invitations to the meetings of the American Institute of Electrical Engineers at which these papers were discussed, to be sent to the Railroad Commissioners or their engineers, or any of their experts, then it is no criticism of the authors for having presented such papers, or of the arguments therein set forth, for us to direct "the attention of those who hold old-fashioned views as to the code of conduct that should control the proceedings of such technical bodies," upon such a dangerous innovation. It is not enough merely to be clean; one must act clean or run grave risk of being misunderstood.—EDITOR.]

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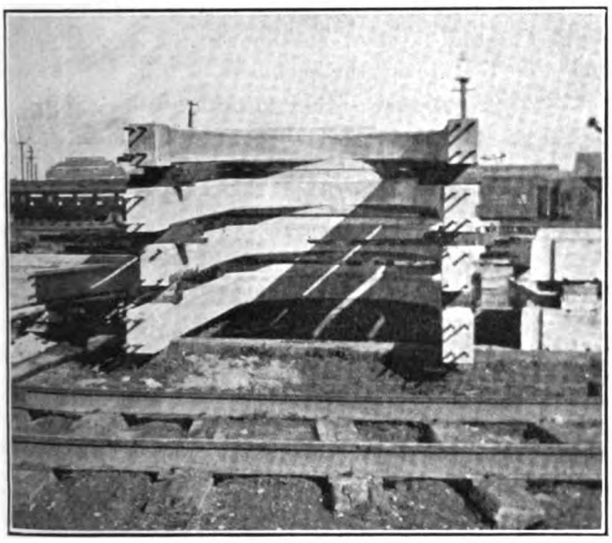
Unit System of Reinforced Concrete for Railway Structures

By SHIRLEY HOUGHTON*

[Editor's Note. This is the first of a series of articles by Mr. Houghton on the unit system of construction. The second, which will appear in the February number, will deal with the construction of the train-sheds for the Southern Pacific depots at San Francisco and Los Angeles and for the Denver Union depot.]

In view of the present tendency of railroads toward permanent construction, a description of recent developments and adaptation of the Unit-Bilt method of reinforced concrete construction to railway structures presents many interesting features.

A large number of reinforced concrete structures have been built in recent years by the Unit-Bilt method. These structures are of many varieties, but are mainly factories and similar industrial buildings. In such structures, as there are a number of exactly similar bays, the Unit-Bilt method of construction is the logical one to employ. By this method the number of standardized-unit structural members is cut down to a minimum and consequently the maximum use is made of each unit form.



VIEW OF CAST UNITS.

The fire risk is very great in the general non-fireproof type of construction usually employed for many railroad buildings. The railway companies of the country would doubtless have adopted reinforced concrete construction but for the fact that the usual or monolithic method of reinforced concrete construction was found to be too expensive for this purpose. This difficulty is now overcome by the use of the Unit-Bilt method of construction.

The Unit-Bilt system is a patented method of reinforced concrete construction, in which all the various members of a structure are molded separately in a casting-yard, set in the structure in independent pieces, and linked together by interlocking the steel reinforcement. From this it will be seen that the difference between the Unit-Bilt method and the ordinary methods of concrete construction is mainly in the fact that the concrete is cast in forms firmly bedded on the ground in a horizontal position, and that these individual units, or separately molded members, when properly seasoned, are then assembled in place in the structure as provided for in the design. There is no difference in the materials used, the difference being only in the manner of procedure.

Some of the advantages of this method of construction are the following:

1. Ease and completeness of inspection of every part of the structure during the entire process of casting and erection.
2. Simplicity of design.
3. Uniform quality of concrete.
4. Reduced shrinking stresses.
5. Joints at predetermined positions, regardless of daily progress of work.
6. Reinforcement in exact position intended by the designer.
7. Maximum strength because of uniform quality.
8. Greater speed of erection because the entire work can be organized in advance.
9. Appearance in finished structure.
10. Reduced cost of forms because they can be removed more quickly.

An important problem in the use of this method of construction is the connection of the units to insure proper stability in the completed structure. This is particularly difficult, as concrete is not a material like steel, which makes it impossible to apply the common practice of structural steel and mill construction connections. This problem has been satisfactorily solved by the Unit Construction Co. of St. Louis, the principle of design of the unit connections being identical to the design of the structure itself, namely, the bond between concrete and steel, sufficient steel being exposed at the connection so that where the joints are filled with concrete, it insures complete development of the strength of the steel and concrete.

In comparing a structure built up of previously molded units with a building built by the monolithic system, it is sometimes assumed that the concrete in the latter structure, being more or less continuously deposited, insures a safer and more rigid building. Such an assumption can only be based on the hypothesis that reliance is placed upon the tensile strength of the con-

*503 Market St., San Francisco.

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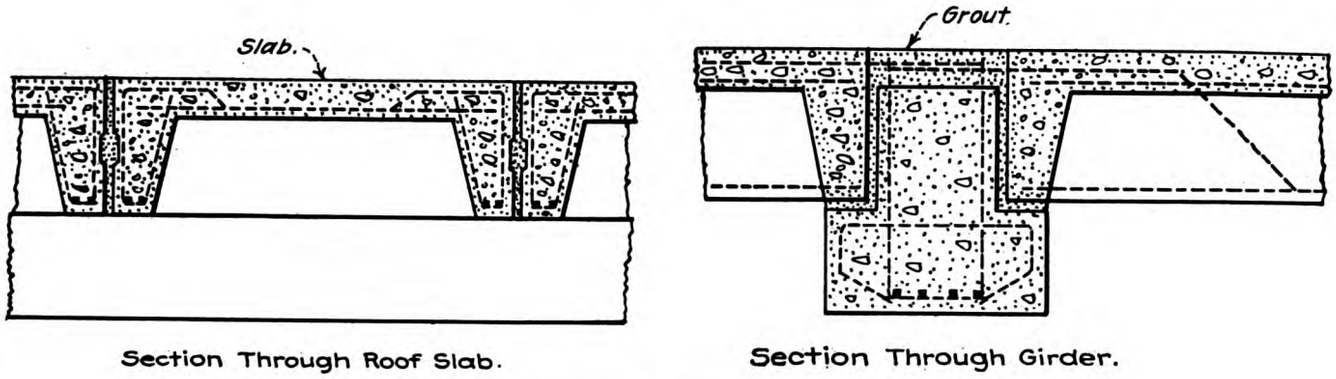

TYPICAL SECTIONS OF UNIT CONSTRUCTION.

crete rather than of the steel. The basis of theory of design of reinforced concrete is the bond between concrete and steel. Therefore, to construct a building of previously molded units it is only necessary to work out the details of connection to insure a proper bond of the steel, to obtain as strong and rigid structures as can be built by the monolithic system. As a matter of fact, the continuous casting of large volumes of monolithic concrete where heavy and light sections such as girders, columns, and slabs are made, has given rise to many problems in concrete construction. The most difficult of these has been the provision of reinforcement to prevent cracks caused by differential temperature expansion and shrinkage of concrete during the period of setting.

Under unit methods, it is possible to follow a well considered program for the work in hand. The forms are bedded on the ground in a suitable casting-yard and the work so arranged that routine operation may be followed. Thus it has become possible to enforce factory methods in construction operations; and factory methods, applied to the contracting field, mean order out of chaos. Intelligent handling and management of the field forces is assisted by unit methods. This is due in part to the fact that the force of men employed is comparatively small, and, being high-class workmen, the common-labor element is almost entirely eliminated. Forms for similar units are grouped together, thus making the inspection and checking of the reinforcement an easy matter. The placing of the steel can be done more easily and with greater accuracy. The reinforcement is locked in position in the forms and there is not the same danger of displacement as in monolithic construction, where there is necessarily considerable walking or wheeling over the steel after it has been placed. It is possible to make thin sections when units such as wall-slabs are cast flat. This results in economy of material. Unit forms can be kept clean. Shavings, sticks, and foreign matter cannot be washed into them from connecting forms, as is the case in monolithic work.

By the unit method, the shrinkage takes place before the member is in position, and the best opportunity for properly taking care of temperature stresses and expansion is afforded by the large number of joints between the new and previously molded concrete. The total movement is so distributed among these joints that the movement at any single point is imperceptible. Each individual unit will have its own internal shrinkage-stresses, but these are not cumulative and do not affect the structure as a whole. The shrinkage of the small amount of grout used cannot affect the structure.

In addition to these advantages as regards theory of design, the unit system has shown the advantage of being able to 'finish' the members within a few days after their being cast. This subject of the 'finish' of concrete is one that is becoming more and more important. On the monolithic structure, where the forms must be left on for weeks after the members are poured, it is impossible to 'finish' the surface, except by cutting or else plastering, neither method being satisfactory. On the other hand, the exposed surfaces of the unit members can be given a variety of treatment. By the proper selection of aggregates, the appearance can be made as artistic as cost will allow.

The unit method has another advantage in the speed in which buildings can be erected. This is a valuable consideration both where replacements are being made, or on new construction, where it is important that the property commence paying interest at the earliest possible moment.

One-man car operation was the subject of a report presented by the Committee on Passenger Traffic before the Convention of the American Electric Railway Association at San Francisco in October. Out of 171 companies reporting, 54 make use of this type of car. In a number of towns of less than 25,000 population, one-man cars are used exclusively. In larger towns, they are used on branch lines where traffic is light. For nearly thirty companies reporting on the use of these cars, the average cost per car-mile for trainman's wages was 3.22c., and the total operating cost 12.72c. Accidents in general were less than where two-man cars were used.

Potash is reduced from wood ashes by pouring hot water on them. This produces a lye solution, which is evaporated in shallow pans to near dryness (6% moisture), when the crude salt is shoveled out. This material is calcined in a reverberatory-furnace, where up to 20% of the weight is lost. Some wood ashes contain a high percentage of potash and phosphoric acid.

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Submarine Pipe-Lines for Loading Tank-Steamers at Tuxpam, Mexico

The following description of methods of loading oil where conditions do not allow ocean-going ships to come near shore is taken from a paper presented before the London Institution of Petroleum Technologists by P. Charteris A. Stewart:

Owing to the unfavorable nature and the comparatively shallow water close to the coast, the Mexican Eagle Oil Co. originated the idea of laying submarine pipe-lines to points where the largest tankers could be conveniently moored for loading purposes at any state of the tide and weather. It has three deep-sea loading-berths at Tuxpam bar, with duplicate pipe-lines to each berth. The Penn Mexican Fuel Co. also has two loading-berths equipped in the same manner with pipe-lines in duplicate.

The first two lines were laid by the Mexican Eagle Oil Co. for the loading of the Oil Fields of Mexico Co.'s oil, in March 1910; these were six inches in diameter, and extended 3608 and 5150 ft., respectively, beyond high-water mark. After being hauled through the breakers, these lines were continued into deep water by laying from barges. This was slow, costly, and unsatisfactory, as on reaching deep water, the pipe developed bends in laying.

As a result of the difficulties experienced with these six-inch lines, the succeeding eight-inch lines, each 5150 ft. long, laid in 1911, were laid on shore on a carefully-prepared wooden track, 12 in. wide, at right-angles to the shore, and directly in line with its permanent position. The pipe was mounted on small wooden trolleys, each running on a single roller; the trolleys were lashed to the pipe at alternate joints. The trolleys were removed during launching by cutting the lashings when they reached the end of the runway, allowing the trolleys to fall into a pit, from which they were removed as the hauling progressed.

The pipe used for the sea-lines complied with the following specifications:

Nominal external diameter, inches	8⅝
Actual external diameter, inches	8⅝
Nominal internal diameter, inches	8
Actual internal diameter, inches	7⅞
Thickness, inches	⅜
Actual weight, pounds per foot	32.26
Threads per inch	8
Angle of thread, degrees	60
Length of thread, inches	3
External diameter of couplings, inches	9 5/32
Length of couplings, inches	7½
Weight of coupling, pounds	30

The total weight of one line was 166,000 pounds.

One hundred and thirty trolleys were used, each taking a weight of 1277 lb. or two joints of pipe. After being laid on shore, the end of the pipe-line was plugged, and the whole line coated with Texaco dip applied hot and wrapped spirally, with burlap in strips 20 in. wide, after which another coat of Texaco dip was applied hot as before.

Uprights with vertical rollers were placed as guides at the water's edge on either side of the runway. A 1¼-in. steel cable, 1750 ft. long, was made fast to the end of the pipe-line, and taken out to the 3000-ton steamer *San Cristobal,* which was used as a tow-boat. In one instance this cable was taken out overnight, and, before hauling commenced, got carried to the south and covered with sand. The first pull was not in the true direction, showing the necessity of the guide-posts. As a rule, however, after making the initial pull by means of her windlass on anchors previously laid ahead, the steamer had no difficulty in keeping on her course, and towing the line at the rate of three to four miles per hour to within a few feet of the buoyed position, the steamer towing the pipe-line being attended by a tug to keep her bow in the correct course, and correct any tendency to drift with the current, the slow speed of the towing not being sufficient to give the steamer steerage-way.

The lines end in 43 ft. of water, which is below wave-action. At the point where the iron pipe ends, 120 ft. of armored flexible hose was attached by divers. The free end of the hose is closed by a blank flange, and is allowed to lie on the sea-bottom when not in use, its position being marked by a small buoy attached to the hose by a chain sufficiently strong to lift it.

The rise and fall of tide is approximately two feet, so that the depth of water, 43 ft., is sufficient for the largest tank steamers to load at any time; tankers of 15,000 tons dead weight drawing 28 ft. are loaded regularly. Vessels loading come into position and moor to the permanent mooring-buoys, and are assisted when required by a tug of 1000 hp. permanently stationed at Tuxpam. After mooring, the tank steamer picks up the marking buoy with the most conveniently situated of her own derricks, and raises the flexible hose alongside the vessel's rail: the hose is attached to the vessel's own loading connections, usually amidships, the weight of the hose remaining on the vessel's derricks.

The necessary control valves for the various lines are on shore, and are so arranged that any loading-pump can be used on any line, or two pumps can be used to load one vessel. The loading-station comprises three pump units, each of a capacity of 1500 bbl. per hour, or a total loading-capacity of 4500 bbl. per hour, the pumps being suitably designed for handling heavy crude oils. They are triple-expansion, duplex, condensing, and can work up to a pump pressure of 450 lb. per square inch. Steam is supplied by water-tube boilers. The station is run continuously, allowing loading to proceed at all times.

With the code of signals in force between the pumping station and the vessel, it is possible to load the largest steamers in almost any weather.

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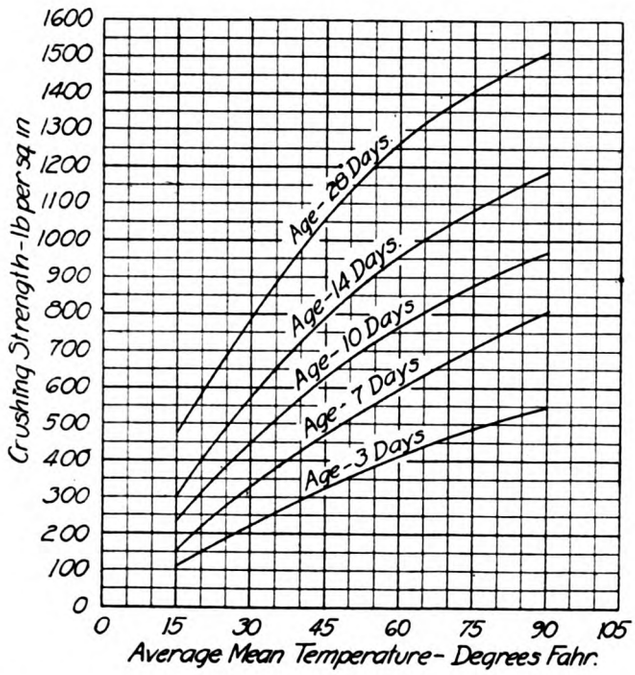
Effect of Low Temperature on the Strength of Concrete

In Bulletin No. 81 of the Engineering Experiment Station of the University of Illinois, A. B. McDaniel discusses the influence of temperature on the strength of concrete. Compression tests were made on 6 by 6-in. cylinder 6-in. cubes, and 8 by 16-in. cylinders. Some of these had been stored at high temperatures and some at temperatures around freezing and below. The curves shown in Fig. 1 and 2 were deduced from the results of the tests. The author gives the following general conclusions.

1. Under uniform temperature conditions, there was

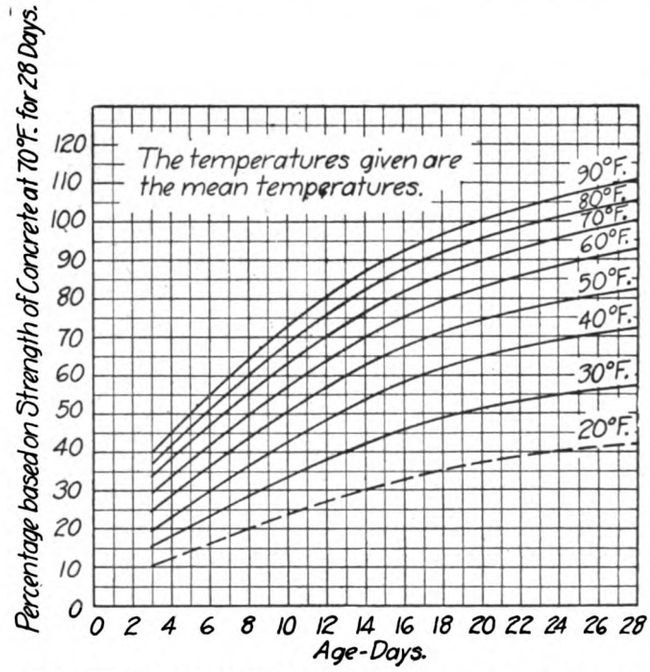


STRENGTH OF CONCRETE AT DIFFERENT AGES AND TEMPERATURES.

an increase of strength with age within the limits of the tests. For any temperature the rate of increase decreases with the age of the specimen; and this rate of increase is less correspondingly at the lower temperature conditions. For the specimens tested, under normal hardening temperature conditions of from 60 to 70°F., the compressive strength of the concrete subjected to a uniform temperature at the ages of 7, 14, and 21 days may be taken as approximately 50%, 75%, and 90% respectively, of the strength at 28 days. For lower temperatures the percentage values are less; and for higher temperatures the percentages are higher. The relation between the percentage values at the ages of 7, 14, 21, and 28 days is nearly the same for temperature conditions from 30 to 70°F. However, the values for the lower temperatures should be used with caution.

2. Concrete which is maintained at a temperature of 60 to 70°F. will at the age of one week have practically double the strength of the same material which is kept at a temperature of 32 to 40°F.

3. Fig. 1 and 2 may be used to determine the representative strength of concrete similar to that used in these tests, for various temperature conditions and for ages up to 28 days. These diagrams may be used with a fair degree of accuracy to ascertain the relative strengths that ordinary concrete may be expected to attain at the different temperatures. It should be noted that in this investigation the specimens generally were stored under temperatures which were nearly uniform



PROPORTIONAL STRENGTH OF CONCRETE STORED AT DIFFERENT TEMPERATURES.

during the whole storage period. For one set of specimens the variations in temperature included a number of alternations above and below the freezing point and the specimens were seriously injured. These results accord with the well-known effect of freezing and thawing upon green concrete.

A mill-refuse burner of novel design is being erected on False creek near Vancouver, British Columbia. It consists of two steel jackets, one inside the other, with the intervening space of 2 ft. filled with water. This double jacket extends to a height of 72 ft. Above that for another 80 ft. the shell is single. The top is covered with two layers of fine steel-wire mesh. This burner insures the refuse being consumed to a fine ash and prevents any possibility of an escape of sparks, burnt sawdust, or refuse. The water-jacket does away with the customary lining of fire brick.

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Methods of Construction of a Concrete-Lined Oil-Storage Reservoir

The construction of a 750,000-bbl. reinforced-concrete lined reservoir built for the Kern Trading & Oil Co. near Bakersfield, California, is described in the Proceedings of the American Society of Civil Engineers by E. D. Cole, who was in charge of the work. The dimensions of the reservoir were as follows:

Inside diameter (bottom), feet	462
Inside diameter (top), feet	528
Depth, feet	22
Width of top of embankment, feet	11
Inside slope	1½:1
Outside slope	1½:1
Thickness of concrete lining (bottom), inches	3
Thickness of concrete lining (top), inches	2½

The material was a light sandy clay, which was handled easily by fresno and wheeled scrapers. After the site was cleared of all brush and grass, the ground under the embankment was plowed and moistened before the fill was started. Water was supplied through a 2-in. line laid just outside the outer line of slope stakes, with hose connections approximately 100 ft. apart. A 2-in. line was also run to the centre of the reservoir to supply water to the portion of the site that could not be reached from the outside line. To avoid being in the way of the scraper-teams, this line was laid through one of the 12-in. outlet-pipes that were placed in position under the fill at the beginning of the work. A narrow trench was dug from the inner end of this outlet-pipe to the centre of the reservoir, and the 2-in. line was laid in it. This line was lowered from time to time as the work progressed in order to keep it clear of the teams. Wetting the material made a more compact bank, reduced the dust, and made the earth ride better in the scrapers. The embankment was made in layers about 3 in. thick, laid parallel to the floor of the reservoir and well compacted. In addition to the tramping of the scraper teams, the fill was compacted by two petrolithic tampers which were driven continually around the top of the embankment.

To insure a compact and uniform backing for the concrete lining, on the inner slope below the natural ground surface, the excavation was started 2 ft. (measured normal to the slope) inside the inner line of slope stakes. After the completion of the main portion of the embankment, a lining of selected material, 3 ft. thick (measured normal to the slope), was built against the inner slope, from sub-grade (1 ft. below floor grade) to the top of the finished fill. This re-fill is an important part of the construction because it would cut off any layers of sand or loose material that might be encountered in that portion of the inner slope which lies below the ground-surface. Neglect of this precaution on other reservoirs had required additional excavation and in one case had resulted in partial failure of the reservoir.

The re-fill was of selected material and was built up by dumping scrapers along the edge of the embankment, the scrapers being driven on the compacted re-fill as it was raised. Fresno scrapers were used for this work at first, but they were discarded in favor of wheel-scrapers. It was hard to keep the fresno scrapers from sliding over the edge of the bank, and they could not be depended upon to build a bench of uniform width. In addition, the wheel scrapers seemed to make a more compact lining.

It will be noted that the completion of this re-fill left a surplus of material 1 ft. thick on the inner slope. This extra foot of material was placed to insure a compact surface and had now to be trimmed to grade. Grade stakes were set on radial lines both at the top and the inner toe of the slope, every 10 ft. around the circumference of the reservoir. Narrow trenches 1 ft. wide and true to grade were then dug from the top to the toe of the slope. Then 2 by 4-in. timbers, 38 ft. long, faced with a narrow strip of strap-iron, were placed in each trench. All excess material above the top of the timbers was removed with a mormon scraper which was dragged up and down the slope, power being furnished by a double-drum hoisting engine at the centre of the reservoir. The 'back-up' line from the engine passed through a snatch-block supported at the top of the slope on a portable wooden truss which was anchored by heavy chains fastened to stakes at the top of the embankment. After the bulk of the material had been removed in this manner, a trimming machine especially designed for the work was used to finish the work. This machine consisted of a rectangular frame, 11 ft. long and 6 ft. wide, made of 6-in. channels bolted together, and carrying two cutting-blades. The cutting-blades were of ⅜ by 12-in. flat rolled steel and projected 2 in. below the bottom of the frame. The machine was dragged up and down the slope, the 2 by 4-in. timbers acting as guides. Nine-tenths of the trimming of slopes was done in this way, at about one-half of the cost of hand-labor. The trimming crew consisted of seven men including the engineer who ran the hoist.

The floor was excavated to a depth of 1 ft. below grade and the sub-grade plowed and rolled before commencing the re-fill upon it. It was then backfilled to grade, the material being placed in thin layers, moistened and rolled with a road-tamper, and finished with a 5-ton roller.

Before the concrete pier-footings for the wooden posts supporting the roof were poured, the floor reinforcement, which consisted of one layer of Clinton fabric, made of No. 6 wire in 6-in. square mesh, was laid over the floor and tied together. The piers were then poured through the reinforcement. This method

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left the reinforcement continuous over the entire floor.

The roof was supported on 6 by 6-in. posts, approximately 18-ft. centres, placed in concentric rings around the floor of the reservoir. The rafters were 2 by 8 in. by 20-ft. pieces, resting on 3 by 12 in. by 18-ft. girders, which were notched in the tops of the posts. The roofing was 1 by 12-in. boards. The entire roof, containing about 600,000 ft. B.M., was constructed in seven days, with a force of 50 men. The roof was covered with 1-ply roofing and a layer of asphaltum and gravel composed of 30 lb. asphalt and 1.35 cu. ft. gravel per 100 sq. ft. of surface. The same kind of reinforcement was used for the sides as for the floor. The concrete was mixed in a 1-yd. Ransome batch-mixer, placed at the outside toe of the slope, and was delivered into a hopper at the toe of the slope inside the reservoir by a hoisting-tower and a 1-yd. automatic dump-bucket. From the hopper it was delivered into concrete buggies and wheeled to the spreading gang. In pouring the floor, a 1½-in. layer of concrete was first spread over a small area, and the reinforcing metal was then raised up through the concrete before the second layer was poured. This was to insure the reinforcement being placed in the middle of the slab. After pouring the slab, the concrete was tamped with wide-faced wooden tampers, and troweled smooth. The joint at the end of a day's work was beveled off, and the next day, before placing concrete against it, was swept clean of loose material and thoroughly grouted with a mortar of neat cement.

The concrete for the slope was delivered from the hoisting-tower into small hoppers set on wagons and hauled with teams around the top of the embankment. From the wagons it was poured directly on the slope. No forms were used, the concrete being mixed so that it would not run any more than enough to facilitate spreading. The slope lining was also put on in two layers. With a fairly 'stiff' mixture, not only was there no trouble in pouring the concrete on the 1½:1 slope, but the author states that he has since constructed a lining on a 1:1 slope in a similar manner. Each day's work was swept on the day following with a wash made of 1 part cement to 1½ parts water. This was to fill any small cracks that might appear while the concrete was taking its final set.

On account of the comparatively heavy reinforcement and the low range of temperature to which the concrete would be subjected, no expansion joints were used. The proper mixture for maximum density of the concrete was computed and the following proportions were used for the floor: 1 part cement, 3 parts sand, 1½ parts of ½-in. crushed rock, and 2½ parts of 1-in. crushed rock. This mixture was satisfactory for the floor, but was found to have too much rock for the slope, as it was difficult to tamp the concrete and prevent it from sloughing to the bottom of the slope. For this reason a mixture of 1 part cement, 2 parts sand, and 2 parts ½-in. crushed rock was substituted. The concrete-crew, consisting of a foreman and 30 men, poured an average of 20,000 sq. ft. of lining per 9-hr. day.

Losses in unlined earth reservoirs are due to seepage and to evaporation. It has been demonstrated that there is practically no loss from seepage in a reservoir that has been properly lined with concrete and where rock not larger than ¾-in. is used for the slab-construction. Seepage losses in unlined reservoirs vary from 1 to 6% per year according to the kind of oil and to local conditions. As a rule a concrete lining for a reservoir will pay for itself in oil saved inside of five years. The cost of concrete-lined reservoirs of this type is from 9½ to 10c. per barrel of storage, distributed about as follows:

	Per bbl., cents.
Earthwork	3
Roof	3
Concrete lining	4

AN UNUSUALLY HIGH TRESTLE FILL

The filling of a 69-ft. trestle on the Western Pacific railroad near Twain, California, presented some unusual problems. Since the ordinary flat-car is considerably longer than the distance between bents, there was danger that the filling-material in falling from such a height would damage the trestle-timbers.

To avoid this, the cross-ties on the trestle were 'staggered' enough to permit laying a 36-in. gauge track alongside the main track and upon the projecting ties. Small dump-cars were run on this track and the material dumped between the ties. This method was used until the fill had reached a height of 45 ft., after which ordinary standard-gauge cars were substituted and the work finished in the usual manner.

The total length of the fill was 1200 ft. and the total quantity 144,000 cubic yards. Material was obtained by widening two cuts near the work, the excavation being done by steam-shovel. The fill was made during the winter of 1913-14 and there was sufficient rain to pack the fill by the time it was completed. The track both shifted and settled considerably during the course of the work, but was kept to line and grade by shimming and there was no interruption to traffic. Palmer, McBride & Quayle, San Francisco, were the contractors.

Charting the Kuskokwim river in Alaska has been completed by the United States Coast and Geodetic Survey during the past season. Among the rivers of Alaska, the Kuskokwim is second only to the Yukon in size, but on account of the large area of hitherto uncharted mud-flats at the river's mouth, it has been visited by only two or three small steamers during the year. The channel through these flats has been charted now. As a supplement to the coast work, a reconnaissance survey was made inland from Bethel, the head of deep-water navigation. By the use of the steamer *Yukon* this was carried up-stream 550 miles to McGrath, the main settlement on the upper river. Earlier maps of the river were found in some places to be as much as 50 miles in error.

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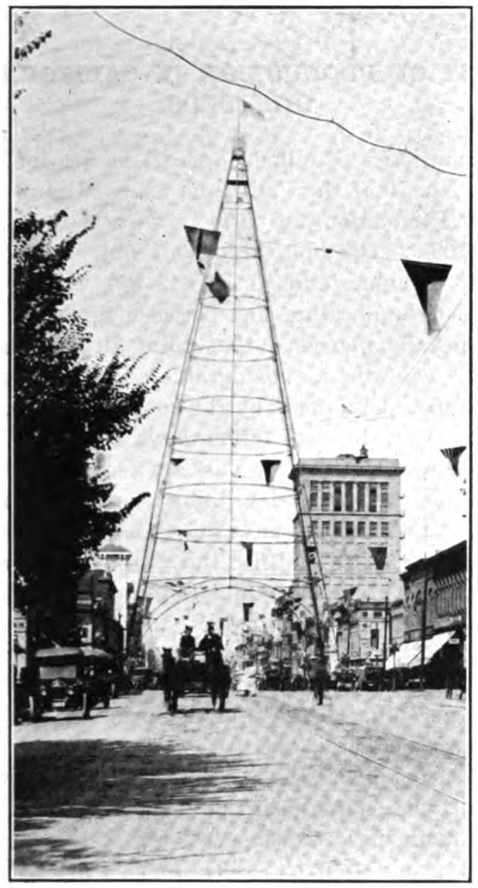
Failure of 200-Ft. Electric-Light Tower at San Jose, California*

On December 3, 1915, at 11:55 a.m., the electric-light tower at the corner of Market and Santa Clara streets, in San Jose, California, collapsed inward. There was a heavy rain and wind-storm at the time. The structure was being repaired at the time and the wreckage fell on the scaffolding and to the street itself. On account of the storm there were few people on the street. No one

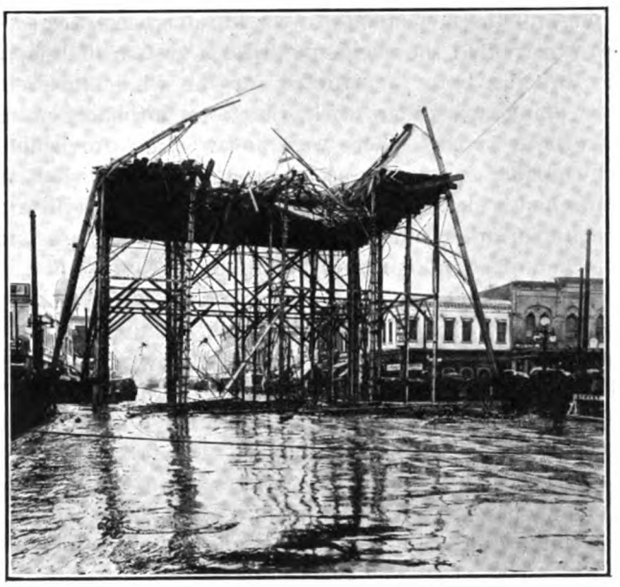


VIEW OF TOWER.

was hurt, nor was there any property damage except to the tower itself.

The tower was built in 1881 at a cost of $3465. Funds for the work were raised mainly by popular subscription. The designs were prepared by John Gash, a local architect. At that time electric lighting was in its infancy, gas being used for most street lighting. It was believed that a few large lighting-units at a considerable elevation would serve for street-illumination. Apparently this belief continued some time after the tower was placed in service. However, it was not long before its uselessness for actual illumination became evident, and for many years past, San Jose has depended on the commoner methods of lighting. The lighting of the tower has been continued, partly as an advertisement of the town, and partly, no doubt, as a matter of sentiment.

The original plans of the tower have long since disappeared. It was 199 ft. high, with a base approximately 75 ft. square. It was made of wrought-iron pipe, screwed together with special couplings of cast iron. The lower portion of the four corner-posts was composed of two pieces of 4-in. pipe resting on a concrete foundation. A single pipe was used for the upper part of the corner-posts, diminishing in size toward the top of the tower. The horizontal and sway bracing was also made of pipe, most of the sway bracing being curved. As nearly as can be determined at the present time, the structure was well designed, probably the only serious fault being that the connections were all threaded without being 'upset.' In consequence, these were by far the weakest point of the structure. With the pass-



WRECKAGE OF TOWER.

age of time, wear on the threads reduced the strength still more.

This condition was rendered worse by the fact that nothing appears to have been done toward the inspection and maintenance of the structure. With each succeeding high wind or slight earthquake, the connections must have been loosened a little more, and additional stresses placed upon some of the members. That the tower stood up for 33 years without any trouble and for 34 before it fell over furnishes the best testimony as to the quality of the original design and workmanship.

The tower gave no trouble until last winter, when it was seriously injured in a wind-storm. It was proposed to take the tower down, but popular sentiment was against it, and after great difficulty, funds were raised to remodel and strengthen it. A design prepared by

*Staff article.

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L. T. Alden and A. A. Pyle, of the engineering department of the State Harbor Commission, and G. J. Adams, of the state architect's office was accepted. The design followed the general plan of the old structure, most of which was to be retained. Steel angles were to be added throughout. The first horizontal brace was 50 ft. from the ground. The next was to be 8 ft. above that, the diagonal bracing cutting this portion into small panels. From there up, the panel-length was from 15 ft. 11 in. to 18 ft. 4 in., with counter-bracing in each panel. This arrangement was to continue to the top of the old tower, where there was to be a lantern 25 ft. high and of ornamental design. At the corner-posts there were to be lighting standards, 22 ft. 10 in. high, with diffusing searchlights.

Contract for the work was awarded to the Golden Gate Iron Works of San Francisco for about $6000. Work was started a short time before the storm, about 50 ft. of the new structure having been erected at the time of the accident. Having a part of the new structure in place stiffened the original tower and doubtless had a good deal to do with its falling inward instead of to one side. If the storm had come a week or two later, enough of the new structure would have been erected to have prevented the accident. Had a system of temporary bracing been constructed for the whole tower before doing any other work, the tower probably would have been saved. There was, however, no provision in the contract for such work being done, and the contract contained a clause placing the burden of any failure on account of other faults than those of workmanship upon the committee in charge rather than the contractors.

An investigating committee composed of C. B. Wing, professor of structural engineering at Stanford University; H. J. Brunnier, structural engineer and one of the judges of designs for the new structure; and L. T. Alden, one of the designers, made an examination of the tower after it fell. It was found that for the reasons already stated, the contractors were not at fault. They are to be paid for all materials and labor furnished up to the time of the failure. It is proposed to complete the tower. The estimated amount to be raised in addition to the sum already on hand is $2500.

Acknowledgment should be made to M. Maggini, city engineer of San Jose, H. J. Brunnier, L. T. Alden, and A. A. Pyle for information, and to J. C. Gordon for the photographs accompanying this article.

Reduction of a steep street-grade by a method similar to the switchbacks in use on light railways is being tried in San Francisco on Larkin stret between Chestnut and Francisco streets. For a width of 28 ft., the east portion of Larkin street will be cut down to descend on a uniform grade of 16.07%. This will be divided into an 18-ft. vitrified-brick roadway and a 10-ft. sidewalk, and will be separated from the west side of the street by a reinforced concrete retaining-wall. The west side descends on flatter grades for 157.5 ft. when the roadway ends in a parked slope. The sidewalk continues in a series of steps to the level of Francisco street. The east portion of the street turns westerly and continues to descend on a 16.07% grade along the south side of Francisco street for 127.5 ft. The south side of Francisco street is to be separated from the lower north side by a reinforced concrete retaining-wall. The roadway turns around the westerly end of this wall through an angle of 180° and descends easterly along the north side of Francisco street on 3.6% grade until it joins Larkin street again. The former grade of Larkin street was 29%. Plans for this improvement were prepared under the direction of M. M. O'Shaughnessy, city engineer of San Francisco, and the contract for the work has been awarded to F. Rolandi.

COST OF PRODUCTION IN CALIFORNIA OILFIELDS

Some statistics of oilfield operations are included in Bulletin No. 70 of the California State Mining Bureau, 'Mineral Production for 1914.' Of the total production of 103,623,695 bbl., 31,923,051 bbl. had a gravity under 18° Baumé, and 71,700,644 bbl. had a gravity over 18°. The dividing line between fuel and refining oil is generally placed at that point although most oil below 18° contains a considerable amount of kerosene and gasoline. Dividends by the companies that confine their activities to production have averaged around $5,000,000 per year for the past six years. The returns from the marketing and refining companies, many of which also produce oil, have been more variable, ranging from $2,981,598 in 1910, the year of the Lakeview gusher and of the boom and collapse of the oil market, to about $9,500,000 in both 1913 and 1914. In 1914 in the Coalinga field the average operating cost per well per day was $10.13; the average production 48.6 bbl.; the cost per bbl., 20.8c.; and the price, 45.2c. In the Kern River field, the operating cost per well per day was $1.99; the average production, 11.3 bbl.; the cost per bbl., 17.6c.; and the price per bbl., 32.9c. In the Midway field, the operating cost per well per day was $9.19; the production, 63.5 bbl.; the cost per bbl., 14.5c.; and the price per bbl., 47.1c. In the Sunset field, the operating cost per well was $12.80; the production, 88.3 bbl.; the cost per bbl., 14.5c.; and the price per bbl. 48c. In McKittrick, Belridge, and Lost Hills, the operating cost per well per day was $4.85; the production, 44.3 bbl.; the cost per bbl., 10.9c.; and the price per bbl., 45.6c. In Santa Maria, Lompoc, and Summerland, the operating cost per well per day was $5.08; the production, 43.9 bbl.; the cost per bbl., 11.6c.; and the price per bbl., 46c. In Ventura the operating cost per well was $2.78; the production, 8.1 bbl.; the cost per bbl., 34.3c.; and the price per bbl., $1.05. In the Los Angeles and Orange county fields the operating cost per well is $4.86; the production, 25.7 bbl.; the cost per bbl., $0.19; and the price per bbl., $0.647. The variation in the cost per well is mainly due to variation in the depth of wells, and in a less degree to their distance apart.

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Proposed Legislation Relative to California Ground-Waters

By CHARLES H. LEE*

Introduction. The use of ground-water sources for irrigation and domestic water-supply is rapidly becoming an important element in the life and industry of California. Statistics presented in the United States irrigation census of 1910 show that the area irrigated by pumping from wells in 1909 was 277,000 acres, and the number of pumped wells was 9297, with a combined capacity of nearly 1000 cu. ft. per second. Since 1910 there has been a very rapid increase in irrigation pumping. From data published by the Office of Experiment Stations, United States Department of Agriculture,[1] the number of pumping plants in 1914 was 24,589, or more than two and one-half times the number in 1909. Assuming that the area under irrigation from pumping plants has increased in the same proportion, the acreage in 1914 would be approximately 700,000. Most of the supply for this area has been developed since 1900. The present total area of land in California irrigated from all sources, is approximately 3,200,000 acres.[2] The area irrigated from ground-water sources has therefore increased from a small proportion of the total irrigated in 1900 to approximately 22% in 1914. Although accurate data is not at hand, it is undoubtedly true that the proportion of ground-water used for domestic, manufacturing, and general municipal purposes is much greater than for irrigation.

This extensive development of a natural resource of which little was previously known, has brought new problems before the people of the State. These problems are being encountered, in one phase or another, wherever the development of ground water is being undertaken, and involve not only the interests of the southern part of the State, but also of central and northern California. Fortunately the California courts have established principles regarding the percolation of underground waters, which, when applied, will conserve such waters and allow their widest possible use. However, there is, as yet, no administrative body with authority to apply these rules where occasion demands. At present, the only means by which they can be put into effect is through expensive litigation between parties themselves.

Underground Reservoirs. The important ground-water supplies of California are derived from porous and usually unconsolidated accumulations of gravel, sand, and clay. The extent and depth of these deposits vary, depending on the area and depth of the depression or basin which they occupy, the amount of available material, and the activity of the streams which are engaged in the work of transportation. In the case of the Sacramento and San Joaquin valleys, the area of transported material covers several thousand square miles. The Coast and Southern California valleys are much smaller, few of them exceeding 100 square miles. This is also true of the coastal-plain areas. The depth of porous water-bearing material, as shown by well-logs, varies from a few feet in the small valleys, to at least 1000 or 1500 ft. in the important valleys and coastal-plain area.

The porous water-bearing materials are, in practically every case, surrounded by relatively non-porous formations. The latter are usually represented by the encircling hills whose slopes dip and meet beneath the valley floor, thus forming enclosing basins or reservoirs. In fact the resemblance is so great that the term 'underground reservoir' has come into quite common use, and has been used by the courts in decisions relating to underground waters in southern California. These terms can be applied not only to the valleys surrounded by hills, but also in many instances to the coastal-plain deposits, for these are quite commonly cut off from the sea by a ridge of impervious material so inconspicuous as to be overlooked by any but the trained observer. Even the water-bearing gravels along the east shore of San Francisco bay, known as 'cones,' are 'underground reservoirs,' for they are merely the higher portions of the great body of alluvial material filling the bottom of the depression or valley now occupied by the bay itself.

The storage capacity of these underground reservoirs is composed of the void spaces between particles of gravel, sand, and silt. This varies in general between 20 and 35% of the total volume, depending on the size of the particles and the proportion of the different sizes. The yield of a well is the amount of water it will drain continuously from the voids surrounding the well for a certain lowering of the water level in the well. The total supply available during any period of time, to all wells in a valley or underground reservoir, is the volume of water in storage in the voids of the gravel deposit above the level from which the water can be economically pumped.

To attempt to pump this entire amount, however, would be wasteful, and would endanger the very life of the community. The purpose of a reservoir is to equalize inflow and outflow. The wise operation of a reservoir demands that a reserve be always kept on hand to provide for periods of drought. To accomplish this, the outflow must never exceed the average inflow less unavoidable reservoir losses. Wise development

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[1]Bulletin 1, Progress Report of Co-operative Irrigation Investigations in California 1912-1914, State of California Department of Engineering.

[2]Bulletin 1 above.

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of underground reservoirs, therefore, must be guided by a knowledge of inflow and reservoir losses.

The mystery which up until a few years ago shrouded the source, movement, and final escape of ground-water, is being rapidly dissipated by the scientific investigation of the United States Geological Survey and other technical organizations, together with the studies made by hydraulic engineers in connection with local water-supply investigations. The primary source of supply of underground reservoirs is now recognized to be the rainfall upon the surface of the reservoir, and upon the tributary mountain water-sheds. This water enters the gravels by percolation either directly from rainfall or from stream-flow and irrigation. The great quantity of water which stream channels or unlined irrigation ditches will absorb, is well known. In passing, however, it may be stated that measurements by the United States Geological Survey on a number of southern California streams, indicate losses as great as 20 cu. ft. per second per mile of channel. On the larger irrigation projects of the San Joaquin valley, the seepage losses from the ditches and fields have caused the ground-water level to rise as much as 50 feet.

The water thus absorbed sinks to the general water-plane and moves toward the lowest part of the valley. Some of the water appears as springs and seepages, which form a stream flowing from the drainage outlet of the valley. A small amount may escape as underflow. In most cases by far the largest part is lost by evaporation from the moist soil and vegetation. The extensive measurements of soil and grass evaporation which I made in Owens valley, California, showed that the average depth of water lost from an area of 55 square miles of damp alkali-crusted soil and meadow land was two feet and for a portion of the area exceeded five feet. In many of the underground reservoirs of southern California, more than 75% of the unused supply is lost by evaporation from soil and plant surfaces; and even in central California the loss is seldom less than 50 per cent.

For any reservoir, whether surface or subterannean, the relation of inflow to outflow is registered by the vertical movement of the water surface. Rising water-level indicates an excess of inflow and vice versa. Under natural conditions, the adjustment of outflow to inflow for ground reservoirs is accomplished by the increase or shrinkage of the evaporating-area and of overflow into natural channels. Thus in the San Bernardino valley, following a series of wet winters, there is always observed an expansion of the artesian area with its accompanying swampy condition, together with increased flow in Warm creek and Santa Ana river, while the reverse is true after dry winters. For a period of years, however, inflow must equal outflow or there will be a persistent lowering of the ground-water levels, shrinkage of evaporating-area, reduction of artesian pressure, and the drying up of springs. Such a condition existed in Southern California during the ten-year dry period ending in 1904; and it still continues in certain Southern California basins where the combined natural and artificial outflow exceeds the rate of inflow.

Determining the limit of the ground-water supply is not only a matter of observing fluctuating ground-water levels, but must also be considered from the broader aspect of the relation of supply to demand. Recent progress in ground-water investigations has shown that it is possible to determine with considerable accuracy the actual quantity of inflow and outflow from underground reservoirs. The Los Angeles aqueduct has recently completed a series of measurements covering a period of three years during which the inflow and outflow were measured, the two quantities agreeing within 10%. Although conditions are not always as ideal as in the Owens valley, yet results can be obtained in most cases which would make intelligent regulation for ground-water reservoirs as possible and practical as for surface reservoirs.

California Court Decisions Relative to Ground-Water. The broad physical features of ground-water supplies as they have thus been outlined, have been, to a large extent, recognized by the California courts in a series of well-known cases, commencing with Katz *v.* Walkinshaw, decided in the year 1903. Prior to this case, the courts had generally accepted the common law rule of diffused percolating waters in dealing with ground-water questions, unless it could be proved conclusively that there was a movement in a well-defined subterannean channel. Under the common law, ground-water is recognized as a part of the soil just as the minerals found there. The exceptions included definite underground streams, the sub-flow of surface streams, percolations tributary to surface streams, and subterannean lakes or artesian basins. The scientific study of ground-water data, made possible largely by the extensive development and use of ground-water in Southern California, has been brought to the attention of the courts in Katz *v.* Walkinshaw and succeeding cases. The trend of these decisions has been to broaden the exceptions of the common law regarding percolating waters and for all practical purposes, to abolish the previous legal distinction between percolating waters and those that flow in a defined subterannean channel.

Samuel C. Wiel[3], in a suggested codification of the decisions on this subject, has recently termed an underground reservoir with its source of supply and outlets "consolidated underground and surface-water supply." He defines it as a "definite body of water upon the surface, and the underground water approximately connected with same in natural occurrence." He then lists the following instances of consolidated underground and surface-water supplies: First, a surface water-course with the underground water tributary thereto. Second, a surface water-course with the sub-flow of underground water immediately surrounding and beneath it and moving with it in the space reasonably well-defined. Third, a definite basin of underground water in a stream entering and depositing water

[3] *Cal. Law Review*, Nov. 1913, Page 26.

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into the basin by seepage from the stream, or with the stream leaving the basin and receiving water from seepage from the basin. The first and second cases are special instances of the third, except where the surface water-course is in a canyon bottom or other restricted body of porous material. Such a body of material with its advancing ground-water, is obviously an underground stream instead of an underground reservoir. A consideration of sources of ground-water supply in practical use in this State, however, show the so-called underground streams to be of minor importance and in many instances to be underground reservoirs on a small scale. Hence, for all practical purposes, Mr. Wiel's "consolidated underground and surface water supply" is the "underground reservoir."

The new rule governing the use of percolating waters occurring in underground reservoirs is now established firmly in California. This rule affirms that a natural ground-water supply is a common benefit for the use of all lands having access to it and that each land owner is entitled to a reasonable use from the common supply upon his own land in conjunction with similar equal use by all other land owners. It furthermore allows use of the ground-water supply on distant lands, in cases where there is a surplus over and above the present reasonable use by the overlying landowners. Thus, the new rule of percolating waters allows the widest possible use of ground-water supplies and has set a precedent which it is hoped will soon be applied to surface waters.

The Need for Ground-Water Legislation. Generally speaking, the reason for legislation relative to ground-water sources is to provide administrative machinery to put into practical effect the rules already laid down by the courts. This and other reasons will be stated and discussed in detail as follows:

First. The surface and ground-water supplies are so intimately related physically, that one cannot be completely regulated and administered without similar control of the other. The physical situation has been set forth in detail in this paper, and no further comment is here necessary. It is evident that the diversion of surface water from one district to another by the storage of flood-waters, under certain conditions, may seriously affect the ground-water supply in the district. Similarly, the extensive development of the ground-water supply may, and often does, materially decrease the flow in streams depending upon percolating waters. The extension or shrinkage of irrigated areas or change in the use of surface water in irrigation, may also materially affect the ground-water supply and indirectly the stream flow. It is the water that is to be considered, not the surface channel. The fact that the water passes beneath the surface and reappears further down the stream, does not offer a logical reason for its exemption from control and regulation.

Second. The use of ground-water sources is in the development stage and rapidly increasing. In many districts, the subterranean supplies are the only remaining supplies or sources of undeveloped water. Hence, if regulation of ground-water sources is to be undertaken at all, the logical time to do so is now, while the situation is in a formative period. With the growth of communities, and the increased demand for ground-water, the problems of just distribution of supply will multiply rapidly. If the users of water are already accustomed to State control, the difficulties of solving these problems will be greatly simplified. Without State control, endless litigation would result with its enormous expense and accompanying hatred and suspicion. The only possible result of such a condition is insecurity for investment and retarded growth of whole districts.

Third. There are a number of important ground reservoirs in the State where the development of ground-water has reached and exceeded the safe yield. Water-levels are persistently falling from year to year, regardless of climatic conditions and the water extracted is at the expense of the storage reservoir which should be maintained for the inevitable series of dry years. There is no way for private parties to oppose such an overdraft except by appeal to the courts. In many instances this is beyond the means of individual landowners and co-operative action is hard to obtain. The interests affected are thus without practical means of meeting the situation.

Fourth. In other ground-water reservoirs, there is a surplus supply which in many instances is being dissipated by evaporation and is a dead loss to the community. The development of such water for beneficial use would not only eliminate the economic waste, but would also in some instances, drain and make fit for cultivation areas of land which are at present water-logged or so heavily charged with alkali that productive crops will not grow. Contemplated development of such water is often opposed by existing interests and there is no financially practical way by which protection can be obtained against litigation. In some cases local interests would not suffer injury at all. In other cases there might result a minor lowering of the water in wells, which if not offset by benefits resulting from land drainage, could easily be compensated by payment of reasonable damages by the new interests.

Fifth. In many of the desert valleys of southern California, settlers, in entire ignorance of the physical situation, are investing money in wells and otherwise preparing to develop ground-water supplies, far in excess of the available yield. This development means economic loss to the individual and the State. In one instance, out of 90,000 acres of agricultural land entered in good faith under the provisions of the desert land and homestead acts, it can be said with reasonable certainty that not more than 2% can ever be put under cultivation. In this valley there has been spent possibly $300,000 in drilling wells, clearing land, and fencing, most of which will be absolutely lost.

Sixth. Water levels are being drawn down and water unnecessarily wasted from many underground reser-

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voirs in which artesian water exists. The effect of this is similar to having the outlet of the reservoir open the year round, whether the water was being used or not. A law was passed by the California state legislature in 1907 and amended in 1909, declaring artesian wells a public nuisance when not equipped with proper mechanical devices with which to arrest their flow, and the waste of artesian water was declared a misdemeanor. The responsibility for enforcing this law lies with the county officers, who are influenced more or less by local public opinion and strong private interests. As a result, the law has not been generally enforced. Impartial State regulation such as that carried out by the State Railroad Commission, would undoubtedly prove more efficient.

Seventh. There is a great need for a systematic collection and scientific study of data relative to ground-water resources, both for the purpose of obtaining information regarding local conditions and for ascertaining broad principles. Such information and study are needed even to a greater extent than in the case of surface-water supply, for the reason that the ground-waters are hidden from view and not to such a great extent a matter of common observation and knowledge. The gathering of such information requires knowledge of conditions over large areas and over extended periods of time and it furthermore requires cooperation on the part of the local people such as drillers of wells, water companies, etc. Such information can only be secured through a technical organization maintained by a disinterested party such as a State or Federal government. The United States Geological Survey has done much toward establishing the general principles relating to origin and movement of ground-water and is beginning to develop the possibilities of quantitative study. However, the funds available for such work are pitifully small and the investigations are scattered through a number of states so that work in California is more or less intermittent and is confined to small areas. There is therefore, much work to be done by the State along this line.

Suggested Legislation. The legislation which will meet the needs outlined above and co-ordinate best with the laws already passed, is as follows:

First. Revise and remodel the present law creating the State Water Commission, so as to remedy the evident defects and omissions, thus giving the officers of the commission full opportunity to demonstrate the efficiency of such a body in dealing with surface-water rights.

Second. When this has been accomplished and the commission has proved its worth to the people of the State, extend the provisions of the law so as to include ground-waters, following the rules so already clearly defined by the courts, but corroborating them as far as possible with the administrative principles already established for surface waters.

Third. In addition to its duties as an administrative body, the commission should be also authorized and provided with funds to maintain a permanent technical organization in charge of a competent hydraulic engineer whose duties should include that of carrying on scientific investigations and studies of ground-water supplies and their relations to surface waters, either independently or in co-operation with the United States Geological Survey. The commission would thus have at its command the machinery necessary for investigation of the difficult, scientific, and technical questions which arise in the determination of the source and amount of percolating ground-waters. A further field for usefulness for such an engineering corps would be issuing of public reports for the information of those interested in the development of ground-water resources.

METHODS AND COST OF REPAIRS TO ASPHALT PAVEMENTS IN CLEVELAND, OHIO

Street repairing in Cleveland, Ohio, is described in a recent number of *Municipal Engineering*. The city has a central asphalt-plant with a capacity of 1500 sq. yd. of completed sheet-asphalt pavement (1-in. binder and 2-in. wearing surface) per day. Four 3-ton automobile trucks with dump bodies are used to distribute the asphalt, and two 5-ton steam rollers. The total cost of the equipment was $29,300. The total tonnage of asphalt for the six months from April to September, 1915, was 5762. The total area of repairs was 58,714 sq. yd. The cost of labor operating the plant was $4232.53, or 7.2c. per sq. yd. The cost of material used was $17,028.47, or 29c. per sq. yd., and the cost of labor in the street was $10,420.14, or 17.9c. per sq. yd., making a total of $31,781.14, or 54.1c. per sq. yd., exclusive of equipment, interest, and truck maintenance. The average operating cost of each truck per day was $6.56. Allowing for interest and depreciation, the total cost per truck per day was $8.43.

USE OF CALIFORNIA OILS FOR DIESEL-ENGINES

In a paper presented before the San Francisco meeting of the American Society of Mechanical Engineers last September, Walter H. Adams gives some data regarding actual performances of Diesel-engine plants operating with California or other heavy oils. An engine on the Jameson ranch at Corona, California, is now running on 'topped' California oil having a gravity of 24 to 26° Baumé. The engine has been run for more than two months without a shut-down. About a quart of kerosene is used twice a day to clean out the pump. The engine was also run for 10 days on 18-degree oil with satisfactory results.

In the Hawaiian Islands, a 600-hp. engine belonging to the Hawaiian Commercial & Sugar Co. was run on a test for a six-day continuous run with California oil of from 14 to 18° gravity. No deposit was found in the valves or heads at the end of the run. Using 20-degree Texas oil, a 120-hp. engine has been running continuously for six months in San Antonio, Texas.

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Design of Rectangular Concrete Beams*

By HOWARD HARDING†

The resisting moment of a reinforced concrete beam, in inch-pounds, may be represented by the formula

$$\text{Resisting moment} = R\,b\,d^2$$

where

b is the breadth of the beam in inches
d is the effective depth in inches
R is a numerical coefficient

The value of R (for a given ratio of the modulus of elasticity of steel to that of concrete) depends upon the proportion of steel reinforcement used and the safe working stresses for steel and concrete. These values of R for different working stresses and percentages of steel have been plotted in convenient curve form in Turneaure and Maurer's 'Principles of Reinforced Concrete.'

For the purposes of this article it will be necessary to cite only a few values of R corresponding to some of the more common working stresses. The ratio of E_s to E_c is taken as 15.

For $f_c = 700$ and $f_s = 16{,}000$
For $f_c = 600$ and $f_s = 16{,}000$
For $f_c = 500$ and $f_s = 16{,}000$
For $f_c = 400$ and $f_s = 16{,}000$

$R = 120$, per cent steel $= 0.87$
$R = 94$, per cent steel $= 0.68$
$R = 71$, per cent steel $= 0.50$
$R = 49$, per cent steel $= 0.34$

In case of reinforcement in excess of the amount required to divide the working-stresses as shown there is a slight gain in strength due to the shifting of the neutral axis toward the steel. When the concrete has reached its working-stress the steel will still be under-stressed. In such cases the value of R used must be the one corresponding to the working stress of concrete and the percentage of reinforcement.

The ordinary method of using the data thus given is that of 'cut and try.' After considerable experience with that method, the growing dissatisfaction prompted the plotting of the equations involved so as to give a direct method of arriving at the result desired. After some study a logarithmic form was adopted which seems to serve the purpose.

On a sheet of logarithmic cross-section paper the values of b were denoted by the horizontal lines intersecting the left-hand ordinate. The left-hand ordinate was called the b scale. Through the origin, that is, through the point 1, 100 of the diagram, draw a line to the right at angle of 45 degrees with the horizontal. By inspection of Fig. 1 it can readily be seen that the point of intersection of any value b with the oblique line, if projected vertically upward to the top horizontal scale of the paper, will give a logarithmic reading exactly equivalent to that of the b scale. Now let the oblique line correspond to $d = 10$ and multiply the readings of the top horizontal scale by 100. Then again by inspection, it will be seen that by projecting vertically the intersection of any value b and the line $d = 10$, we may read directly the corresponding value of $b\,d^2$. For values of d other than 10 there is a family of lines parallel to the line $d = 10$.

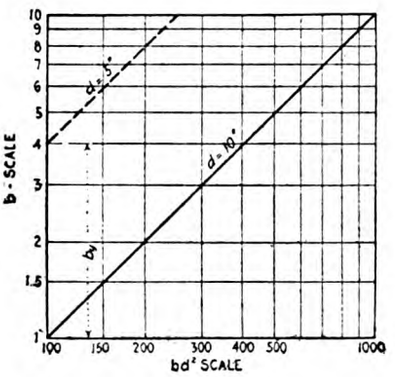

FIG. 1. DIAGRAM FOR CHECKING RELATIONS INDICATED BY EQUATION.

It now remains to introduce the factor R into the diagram. A range of from 40 to 120 for this co-efficient will be found to cover about all cases likely to arise. Since the bending moment is ordinarily computed in foot-pounds we may write our fundamental formula to correspond to those units.

Then

$$\text{Resisting moment} = R\,\frac{b\,d^2}{12}$$

and when $R = 120$

$$\text{Resisting moment} = 10\,b\,d^2$$

By projecting the values of the $b\,d^2$ scale to a horizontal scale whose readings are 10 times that of the $b\,d^2$ scale, we obtain directly the resisting moment in foot-pounds corresponding to any value of $b\,d^2$ and $R = 120$. The diagram is arranged to care for other values of R by taking the proper fractional part of the resisting moment of the beam at $R = 120$. Thus, for $R = 60$, one-half of the resisting moment of the beam at $R = 120$ is taken. This is done graphically by proceeding upward to the horizontal line representing the desired value of R and thence proceeding along the oblique line to the top scale where the resisting moment in foot-pounds is read.

In the lower part of the diagram it will be noticed

*Presented before the American Society of Mechanical Engineers, June 1915.

†Rochester, New York.

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that there are two other families of oblique lines. One of these shows the ratio of d to b and the other the cross-sectional area or the product of d times b.

The method of using the diagram is ordinarily just the reverse of the order in which it has been developed. First decide upon the working stresses and determine the corresponding value of R and the percentage of reinforcement. Then compute the bending moment in foot-pounds which it is desired that the beam should withstand. Locate the bending moment thus computed at the top of the diagram, Fig. 2. Thence proceed parallel to the oblique lines until the value of R previously determined is intersected. From this intersection proceed vertically, intersecting the horizontal lines representing breadth, and the oblique lines representing depth. At any one of these intersections the required breadth and depth may be read. Any of the corresponding dimensions will satisfy the condition for strength, but the dimensions will depend upon the shape of beam desired. If we wish a certain ratio of depth to breadth we can obtain it by stopping at the dotted line representing that ratio. If a certain depth or a certain breadth is desired it is necessary to proceed vertically until said depth or breadth is intersected and the point of intersection automatically determines the value of the other dimension.

In a beam of dimensions as determined by the use of the diagram in Fig. 2 no allowance has been made for the bending moment of the beam due to its own dead weight. To take care of this additional bending moment, the strength of the beam may be increased in three different ways, namely, (a) by increasing both breadth and depth, (b) by increasing depth only, and (c) by increasing breadth only.

Where k is the multiplying factor, the following formulae may be used:

Increasing strength by increasing breadth and depth:

$$\left\{\frac{(1.56\ k^2)}{k^3-1}\right\}\ l^2 = R\,d$$

Increasing strength by increasing depth only:

$$\left\{\frac{(1.56\ k)}{k^2-1}\right\}\ l^2 = R\,d$$

Increasing strength by increasing breadth only:

$$\left\{\frac{(1.56\ k)}{k-1}\right\}\ l^2 = R\,d$$

It will be noted that the form of the three expressions just developed is the same, the only variation being in the exponent of the term k enclosed in the parentheses.

To summarize the foregoing it may be well to work out the problem in detail. The writer has found the following to be a very convenient and useful form of computation:

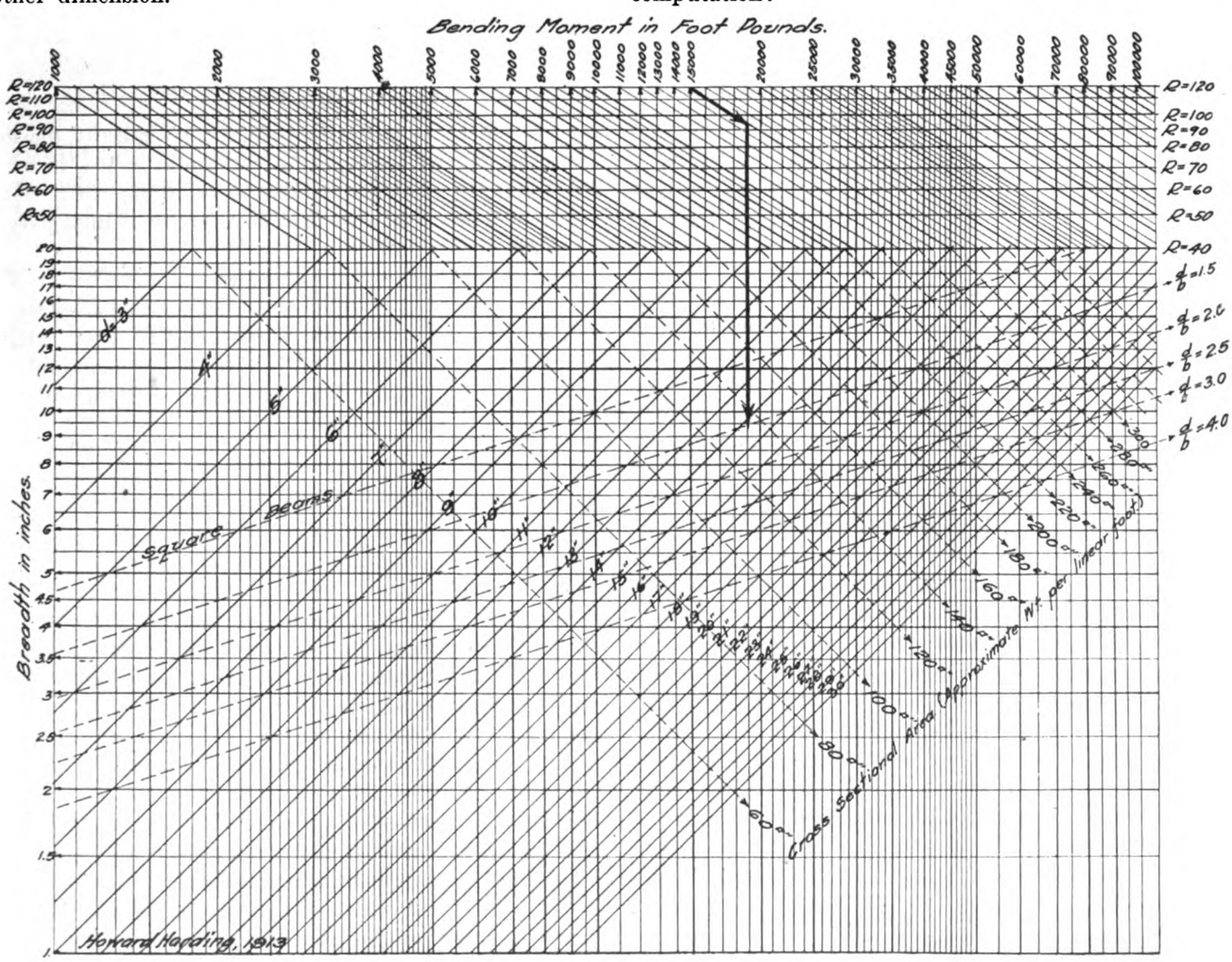

FIG. 2. DIAGRAM FOR GRAPHICAL DETERMINATION OF RESISTING MOMENT OF REINFORCED CONCRETE BEAMS.

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Span = 18 ft. Load = 370 lb. per. lin. ft.

Bending moment = $\frac{wl^2}{8} = \frac{370 \times 18^2}{8} = 15{,}000$ ft. lb.

Shear = 3330 lb. + $\frac{1}{2}$ weight of beam

$f_s = 16{,}000$. $f_c = 600$. $R = 94\%$ steel = 0.68 sq. steel rods

$b \times d$	9.4×14.10
k	1.145
$b \times d$	10.8×16.2
$b \times d$	175
Unit shear	28

Steel, three $\frac{9}{16}$-in. bars, or two $\frac{11}{16}$-in. bars

The correction factor used was the one corresponding to the increase in both dimensions. It should be noted that d represents the effective depth, and the distance from the steel reinforcing to the bottom af the beam must be added to get the total depth. This 'cover' portion of the beam has been neglected in all of the computations for strength. The determination beam is plainly indicated on the diagram so that the method may be readily understood.

REINFORCED CONCRETE BRIDGES WITH FLOORS BELOW HIGH-WATER MARK

An unusual type of bridge for stream-crossings in arid regions is recommended by W. S. Gearhart, state engineer of Kansas, in a paper presented before the Pan-American Road Congress. As is usual in such regions, the stream-beds are dry during most of the year but become torrents after a rain. The problem of the design of an inexpensive bridge to meet such conditions is complicated by the fact that during the dry period the ravines become filled with Russian thistles. When the floods come, these are swept down-stream catching other drift as they go. The entire mass piles up against the first bridge, choking the waterway and sometimes causing the destruction of the bridge. As the stream-beds are sandy, fording is difficult, if not impossible, and some provision for crossing is necessary even on light-traffic roads. Concrete and reinforced concrete pavement has been used, but even with deep curtain-walls, there is danger of failure due to undermining.

The present practice is to construct a reinforced bridge with an opening just large enough to carry the ordinary flow and to permit removal of accumulated debris. The top of the bridge is below the elevation at which the stream carries much drift. Consequently the water flows over the top of the bridge before the drift begins to come down and the latter passes over the bridge without lodging and choking the waterway.

A bridge of this type was constructed at Ashland, Kansas, in 1910. Its length is 60 ft. over all. It is composed of three spans of reinforced concrete slabs, with piers and abutments of plain concrete. The clear width of roadway is 18 ft. The footings were carried about five feet below the bed of the stream and from six to twelve inches into the bedrock. The bottom of the slabs is about 16 in. above the bed of the stream and the total height of the bridge above the same point is 3 ft. Floods in that region are of such short duration that the bridge is under water only about eight or ten hours at a time and that not more than once or twice a year. The bridge has been under ten or twelve feet of water several times without damage. The bridge cost $1220, whereas a high steel bridge would have cost $2500. There are ten or fifteen bridges of this type in western Kansas, and plans have been completed recently for a 574-ft. bridge across the Cimarron river in Morton county.

THE HETCH-HETCHY RAILROAD

Contract for the construction of a railroad from Rosasco on the Sierra railway to the proposed dam-site in the Hetch-Hetchy valley has been awarded to F. Rolandi, of San Francisco, for $1,543,080. The unit bids for the work were noted in WESTERN ENGINEERING for December, 1915. This road is to be built for the city of San Francisco. Its primary purpose is to haul materials for the large dam and other structures in connection with the development of the Hetch-Hetchy water-supply, but it is expected that there will be ultimately some local traffic. The grading will be 16,000 cu. yd. per mile on an average. The country traversed is rough and mountainous. From Rosasco to Groveland, a distance of about 20 miles, the work is not quite so heavy as for the remainder of the road. The total distance is 67 miles which includes the nine miles from the Hog Ranch to the floor of the valley that was graded last winter. Construction of this part of the road was described in WESTERN ENGINEERING for June, 1915. The present contract includes laying track on this portion of the road.

The maximum curvature is 30° and the maximum grade, 4%, compensated 0.04 ft. per degree of curvature. The roadbed is 16 ft. wide in both cuts and fills. Besides a number of corrugated pipe and concrete culverts, there will be a steel bridge across the Tuolumne river. This will have a centre span of 220 ft. with plate-girder approaches, the length of which has not yet been determined exactly. The structure is to be designed for Cooper's E-35 loading. The contractor is to prepare plans for the bridge, subject to the approval of the city engineer. Plans for the entire work as well as the actual construction will be under the supervision of M. M. O'Shaughnessy, city engineer of San Francisco.

Dumping sand and stone on or near the sub-grade when constructing a concrete road was avoided by the contractor on a stretch of highway recently constructed near South Bend, Indiana. An industrial railway was used. Each car was loaded with the amount of cement, sand, and gravel needed for one batch of the mixer. On arriving at the work, the cars were dumped directly into the mixer, which was equipped with an especially designed side-loading device. Three trains were used, the idea being to have one train being loaded, one train on the road, and one train unloading at the mixer all the time.

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Use of Mud-Laden Fluid in Oklahoma Oil-Well Drilling*

By R. P. McLAUGHLIN†

Briefly stated the mud-laden fluid process of drilling oil-wells consists of circulating mud along the walls of the drilling-well, as is always done when rotary tools are used or when a circulator is used in conjunction with cable tools. The proposed advances in method aim, by using perfectly clean mud under several hundred pounds pressure, to seal off all water, oil, or gas-bearing sands and to leave a solid column of mud behind the casing when it is landed. The theory is that by this method the intermingling of oil and water will be prevented, even though several strata were exposed behind only one string of casing.

My conclusion from this and previous investigations, is that some of the claims advanced as to the usefulness of the process have not been sufficiently demonstrated. The process has for some years been used in this State to prevent the wasting of gas, and the United States Bureau of Mines and the Corporation Commission of Oklahoma are engaged in the useful work of introducing it among the operators of that State.

Underground conditions in Oklahoma and Kansas are scarcely comparable to those existing here. In those States the formations are so hard that rotary tools are seldom or never used. The wells will frequently stand open with little or no casing, and the oil sands are so hard and compact that they must be shattered with nitro-glycerine in order to obtain a satisfactory flow of oil. Infiltration of water seems to be of slight importance. Conditions in California are diametrically opposite.

There were, however, some cases observed which indicate at least that mud may serve to shut off water, and brief mention of them will be made.

In the Cushing field, there are two productive oil-sands, the Laton at a depth of about 1500 ft., and the Bartlesville at a depth of about 2500 ft. At a depth of about 1200 ft. is a sand carrying salt water under a hydraulic head of about 1000 ft. The Prairie Oil and Gas Co., a large operator in the field, drills separate wells for the two sands. The deep and shallow wells are frequently less than a hundred feet apart. In the deep wells a single string of casing, backed with mud, penetrates both the upper oil-sand and the salt-water sand. No ill effects from water are reported in the shallow wells, although these conditions have existed for about six months at some wells.

At Augusta, Kansas, there are sands at a depth of about 1400 to 1500 ft. carrying commercial quantities of gas with a rock pressure of about 600 lb. per sq. in. At about 2500 ft. there is a productive oil-sand. There is a good deal of water above and below the gas. The Wichita Pipe Line Co. operates most of the wells of the field and drills separate wells, about a quarter of a mile apart, to produce oil and gas. In the deep wells a single string of casing, backed by mud, penetrates both the gas and water-sands. No flooding of the gas-sand has been noted after three months.

At Fowlerton, Texas, two water-wells, drilled with rotary tools in 1911, are reported. The first struck fresh water at about 500 ft., flowing about 30 gallons per minute over the casing. The second well, about 50 ft. away, was drilled to nearly 1900 ft. and between 800 and 1000 ft. struck an artesian flow of salt water amounting to about 1200 gallons per minute. Thick mud was circulated back of casing driven to a depth of 1100 ft. and while the shallow well was in use, some three or four months, there was no contamination of the water.

The process may reasonably be presumed to accomplish several things greatly to be desired in California, especially a reduction in cost of drilling wells. However, as the State Mining Bureau is engaged in practical work, theory cannot be the sole recommendation of this or any other problem. Doubtless some operators will be more than willing to use the mud-fluid method of shutting off water immediately, as it will be much less expensive than the ordinary methods now in use.

I would recommend that the owners of a limited number of wells be permitted to drill with the mud-fluid process, in selected districts where the after effects can be definitely studied, and if necessary, corrected without undue injury to surrounding property. The work should be allowed to proceed only under definite specifications to be furnished by the State Mining Bureau.

*From report to F. McN. Hamilton, State Mineralogist.

†State Oil and Gas Supervisor, Ferry Bdg., San Francisco.

Hardening of concrete is accelerated materially by the use of calcium chloride, according to the United States Bureau of Standards. It was found that 4% of calcium chloride added to the mixing-water increased the strength of the concrete at the age of one day 100% or more. In some cases the strength of the two-day old concrete mixed with calcium chloride was as much as 75% of the strength of ordinary-mixed concrete at the end of a month.

The best proportion of water in mixing concrete to obtain the maximum strength has been investigated at the testing laboratory of the Sheffield Scientific School, according to *The Scientific American*. A 1:2:4 mixture of concrete was used with varying proportions of water, and the specimens were all tested after 30 days. Concrete mixed with 27½% of water showed the greatest strength, both in tension and in compression.

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Measurement Methods for Quarry and Open-Cut

By C. S. GALBRAITH*

Although the data available to the railway construction engineer and contractor for the measurement of earthwork are ample, those dealing with large excavation work, such as quarries, open-cuts, and hydraulic mining operations, are incomplete and uncomprehensive. By the adoption of common-sense methods one may get through. However, the two systems described below will, it is hoped, be of interest and service to those who wish to employ a system of measurement. Those who lack such would be well advised not to procrastinate longer, as reliable costs per cubic yard cannot be obtained without careful periodical measurements of output.

In most mines nowadays, actual weights are taken as the ore travels from mine and mill. Where either mining or milling is carried out by contract, or when metal contents are variable, this system needs no defence. But when ore is of a uniform character, and mined by wages-men, measurements without weighing may often be substituted with advantage from the points of view of saving time and cost. No hard and fast rule can be laid down, and it is for the management in each case to decide upon the policy adopted.

Some few years ago, I had a large sandstone excavation to make on the foreshore of Jones bay, near Sydney, Australia. The land, which rose steeply almost from the water's edge was required for further wharfage accommodation. It was decided to excavate the cliff foreshore down to wharf-level (R.L. 14.00), and tip the spoil so as to form two separate peninsulas jutting out from the shore, and around which concrete wharves were to be built. The anticipated time for the job was two years, and as no similar work was in view, the purchase of an elaborate compressor plant would not have been justified. This desideratum, fortunately, was overcome by renting a motor generator of some 85 k.w. capacity on very favorable terms, dismantling the dynamo, and substituting therefor a shaft fitted with two pulleys. An Ingersoll-Rand type NF belt-driven compressor and three D-24 I.-R. drills were purchased, together with a few 'Jackhamers.' An air pipe-line was laid along a road at the back of the contemplated excavation, which was about half a mile long by an average of 300 ft. wide and 30 ft. deep.

It was the intention to duplicate the compressor and drill plant when sufficient faces had been 'opened-up,' but a curtailment of State funds for this work necessitated slower progress than that anticipated and the original plant is still at work. The following system of measurement was inaugurated.

Cost Keeping. *A.* Before commencing operations, the surface was laid out by ordinate lines 30 ft. apart, and at right angles to a base-line close to the water, and at the wharf-level. Longitudinal lines 30 ft. apart were also put down parallel to the base. A peg was placed at each intersection and peg-levels taken. The base-line was also connected with a high level roadway, curb-line by survey, so that check methods from this back road-line could be obtained if necessary. Contour-plan, and also longitudinal and cross-sections along each line were plotted for future use, and the whole area was divided into portions having a convenient size for office use. Cross-sections for each portion were plotted on cross-section cards. As the excavations advanced, the work done each month was marked and the quantity and cost recorded thereon. Monthly comparisons were therefore seen at a glance and the organization kept up to the mark.

The rock consisted of tough sandstone with occasional ironstone bands. A useful quantity of beautiful brown building-stone could have been obtained, but storage-space was not available. Diagonal fissures developed, and as these were naturally made use of for blasting purposes, the originally determined bench-method of quarrying was partly abandoned, and with it the cross-section system of measurement. A combination of this latter and theodolite stadia-reading was adopted, the latter only for irregular and steep faces.

I became familiar with both the above mentioned systems from intimacy with the work done at the Mount Lyell copper mine and the Briseis tin mine, Tasmania. Both of these companies are large concerns and are wonderfuly well organized and managed, the former by Robert Stitcht, an American who came from Butte and who is a skilled copper metallurgist. The Briseis mine, which consists of a placer deposit of cassiterite-bearing drift yielding about 0.66 lb. mineral per cubic yard, was in poor condition when Lindsay Clark, of Melbourne, took charge and saved the situation. One of the features of this mine is a 29-mile water-race ending in a head of over 350 ft. The excavations there are large and irregular. Generally a slight batter obtains, but often the face is undermined and a reverse batter results. Theodolite stadia-readings are the only satisfactory means of measurement in this case and a description of the actual system employed there is given below.

The Mount Lyell mine, at Queenstown, Tasmania, is an enormous 'blow' of iron pyrite. Originally near the surface it was worked entirely for gold, which soon gave way to copper ore, up to 7% metal. Metal-content decreased and today the average copper is down to about 1%. The small gold and silver contents, together

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with the better class North Lyell ore still allow this company to remain on the dividend list, even with copper at a minimum. The mine from a distance appears as a huge amphitheatre, the open-cut being about 300 ft. deep. Benches are 35 ft. in depth, the upper benches almost entirely in overburden. The following method of measurement has been in use in connection with the open-cut workings for some years and has proved most satisfactory.

B. In plan the excavation is marked with pegs in squares, the dimension of which can be varied, but 30 by 30 ft. is most convenient. A permanent base-line is laid down, so that it can readily be picked up and worked from. Cross and longitudinal lines are also laid-down at right angles and parallel with this base, respectively, with pegs at intersections of same. As a

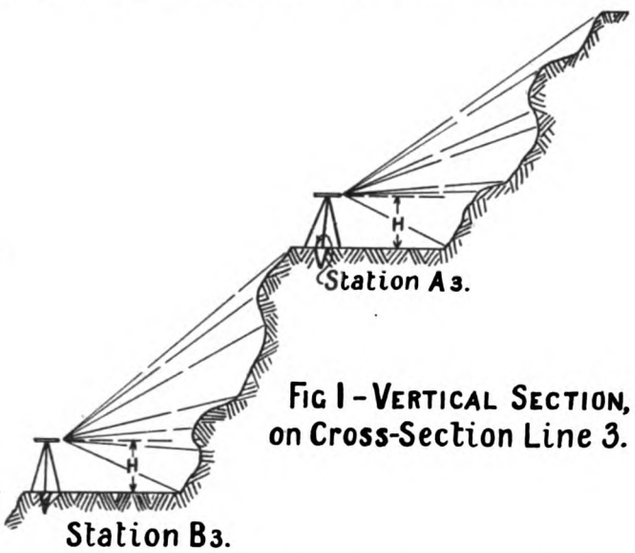

FIG 1 - VERTICAL SECTION, on Cross-Section Line 3.

preliminary, the level of each peg is taken and recorded on the original contour-plan.

As the excavation advances and the original base-line becomes too far distant for convenience, a secondary base is established parallel with the first. A convenient advance between 'bases' is 60 ft. Though convenient to mark on the surface into pegged squares as above described, this is by no means essential, and measurement operations on this system can be commenced at any time in old workings by establishing a base-line and advancing the lines in chess-board fashion. As many intersections as possible should be pegged, the pegs being stamped with both (*a*) cross-section line number and (*b*) base-line number. Measurement work can then be started anywhere, suiting the covenience of both surveyor and mining superintendent.

When the measurements required are for one bench only, the theodolite is set up at one end of the base-line and at its intersection with No. 1 cross-section line. Sighting along this latter, the vertical angle is read to each prominent point on the face (see Fig. 1) and the distance measured. With two chain-men, one reads the tape at the instrument station and the other goes up the 'batter' (if accessible) with the zero end of the tape and a level-rod. The latter is used in the event of the zero end of the tape not being held on the point sighted to, a staff-reading is taken then; sometimes by fixing the end of the tape to the rod (by means of a hook for the purpose) the chain-man may reach the sighted point.

When faces are inaccessible, a chain-man (or boy) can be sent with advantage to the top of the bench, where, by means of a rope, with weight attached the latter may be lowered to the point required, and a sight given. Generally all apparently inaccessible points can be got in this way. By attaching the end of the tape to the weight and starting by sighting to the lowest point required, the weight is drawn up along the cross-section line, and so all points are recorded. Long sights should be avoided, 150 ft. is a fair maximum, and if a cross-section line is over this distance, it is well to

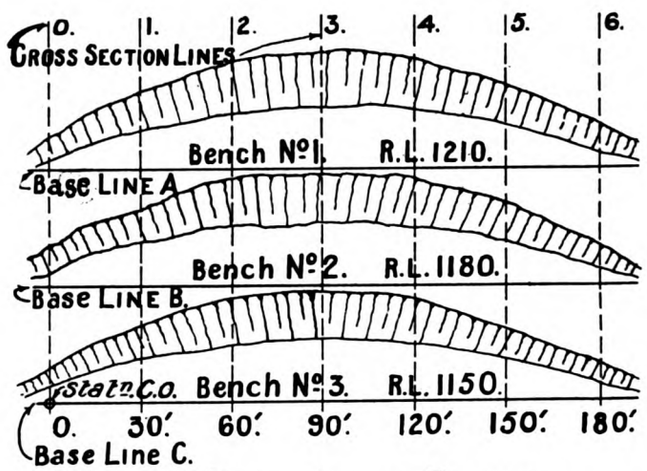

FIG 2 - PLAN SHOWING BENCHES

set-up at another point and continue. Generally one 'set-up' on each bench for each cross-section is good practice. Notwithstanding the fact that in some cases one's field work is fragmentary, the plotting will, with care, give accurate results.

By good selection of the line of sight (quite easy with a little practice) a lot of 'shots' can be eliminated. Fig. 3 shows a vertical section to illustrate this feature. The selected line of sight is uninterrupted to the top of the bench, the staff is shown on all requisite points, and distances taken. Of course, the height of line of collimation above the station peg must be taken for each 'set-up' and all pegs leveled to a bench-mark, so that reduced levels can be deduced for plotting.

All computations can be quickly and accurately done by scaling from the contour-plan and sections. Either 20 or 30 ft. to one inch are handy scales, but the latter is preferable, as yards are the desired unit.

A planimeter is recommended for taking out areas. After each periodical measuring, the position of the face and date should be marked on both plan and sections.

The area between the line of face on the new and the measurement day will be the amount excavated on each cross-section line. (See Fig. 4.) The sum of all

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such areas for all cross-section lines (throughout the quarry), multiplied by the common distance apart of the cross-sections, gives the total quantity excavated for the period under review. With average work the error involved by this method is only about 2%.

C. When the faces are too steep and irregular for the above systems, the following is recommended for adoption: The features are, few 'station points'—from which vertical angles and azimuths are taken to all prominent and requisite points, with stadia readings and distances at, and to, each. A contour-plan is plotted from the information thus obtained in the field and this plan is cut up in chess-board fashion with cross and longitudinal section lines as before, and as close together as necessary.

If commencing a new quarry, an original contour-plan of the surface should be made, with cutting-up into sectional lines, and 'spot' levels taken on intersection pegs as above. A permanent base-line would also be established. Contours should be plotted every 5 ft., with anticipated steep faces, and a scale of 30 ft. =1 inch (giving 100 sq. yd. per sq. in. of plan) is the most useful scale.

In laying out new country, lines 100 ft. apart with intersection pegs (leveled) make a good arrangement; and generally a base parallel with one boundary of the property (or along the meridian) is good practice. The intersection pegs are used as instrument stations for the more detailed measurement surveys—during operations—in which the theodolite only is used for instrumental work. Procedure is as follows:

(*a*) Set-up over one peg.

(*b*) Take height of line of collimation, reading the staff.

(*c*) Take sights to staff, shown on all requisite points on face (that is, at all changes of configuration), observing,

1. Angle of elevation (or depression);
2. Azimuth (or bearing);
3. Stadia reading (for distance);
4. Rod reading (height at which line of collimation cuts rod).

NOTE: The rod should be held perpendicular to the line of sight. Fig. 5 shows a device to ensure this important condition. This device consists of a sheet-zinc socket fastened to a flat board carrying two tails, the line joining which is at right angles to the staff. When the surveyor gets these two nails in line, the rod is perpendicular to the line of sight. The staff-man moves the staff backward or forward until signalled "steady."

Field-notes are conveniently kept in an ordinary level-book, with appropriate alterations to headings. A sample page is shown thus:

The angle of elevation must be read as near the foot of staff as possible, otherwise corrections for both heights and distances would be necessary ($H' = H$ sin. elevation, etc.).

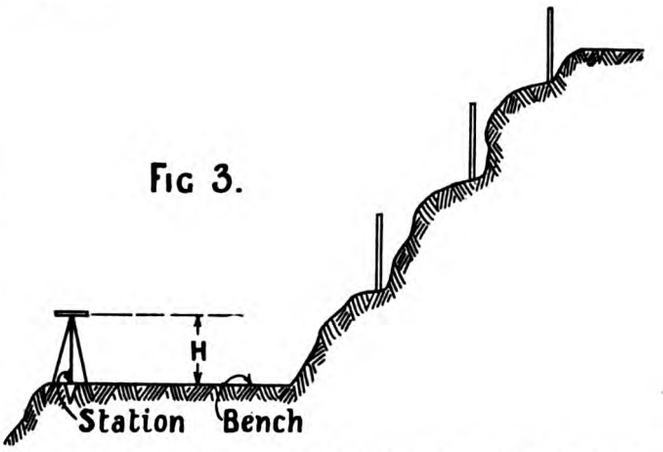

FIG 3.

The new contours are best drawn by using a proportional compass, although an offset-scale will serve. These contours should be drawn in pencil, as the 'new' lines vary every month (or period of measurement). If desired, each monthly contour-plan may be plotted on tracing-paper and this placed over the original plan

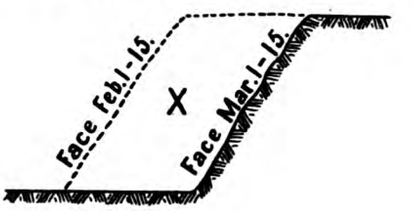

FIG. 4.

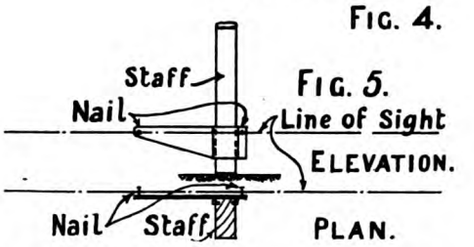

FIG. 5.

in order to read the excavated areas for the period under review. However, once the data are obtained, all that is required has been accomplished, and successive rubbings do not injure the original plan if the pencil plotting is done lightly and reasonable care taken. One plan only is necessary. The areas between original and new contour-lines are read with a plainmeter in square yards.

The figures underlined are known, or calculated, after field-work is finished; field-entries are not underlined in the above sample. The height of line of collimation (instrument above) is read 4.80 above peg at station C, the reduced level of which is known, viz.: 330. The R.L. of line of collimation is therefore (330

Instrument at Station C-330; height, 334.80 feet.

Bearing.	Distance.	Inclination.	Rise, feet.	Fall, feet.	Reduced elevation, feet.	Horizontal distance, feet.	Remarks.
180°	187	4°30′	13.5	3.0	345.30	186	Top of cut-grass.
186°	190	5°10′	16.8	2.0	349.60	189	Foot of old face.

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+ 4.80) = 334.80. This is entered in brackets simply as a precaution. A horizontal angle is read to one or more station-points—280° to "Station D," 2nd line.

The first 'shot' is to "top of cut-grass" (*i. e.*, natural surface), azimuth 180°; chainage 187 ft; angle of elevation (+ sign indicates elevation, and — sign depression) = 4°30′; stadia reading = 3 feet.

The office work for this particular sight consists of calculating

(*a*) True rise,
(*b*) Horizontal distance,
(*c*) Reduced level.

These are shown underlined, though in practice it is well to enter the calculated data in ink. When all the data are thus collected they are then plotted upon the office contour-plan, and subdivided into chess-board squares as before mentioned.

The total area excavated for the month (or regular period) in cubic yards = $\frac{\text{Sum of areas} \times 5^*}{3}$ cubic yards.

For irregular excavations when the contours are close together and the faces high, results from this method are satisfactory and better than those from the cross-section method *B*. The field-work is much less than in *B*, and more quickly put through. Cross-sections, *B* method, are with difficulty put close enough together for conditions assumed above.

For distances up to 300 ft. stadia-readings give good results. The stadia-wires may be conveniently arranged so that 1 ft. on staff equals 100 ft. in length. With one wire above and one below the central wire, half-readings can then be taken for greater accuracy.

In conclusion, it may be added that this method can be applied most successfully to the measurement of mine stopes. A contour-plan of the roof is plotted periodically in the manner above described.

Each superintendent can with practice adopt his own methods to suit his own job, but the above description is sufficient to allow the systems quoted being started and those who investigate will find either well worth trial.

The increased efficiency and economy of operations in the California oilfields as compared with a few years ago is exemplified by the report of the Kern River Oilfields, Ltd., an English corporation which operates a large property in the Kern River field. Operating expenses decreased by 28% in 1911-12 as compared with the previous year, by another 22% in 1913, by another 18% in 1913-14, and by another 20% in 1914-15. The figures for production for the entire period are not at hand but the net output for the past year was 771,838 bbl., and for the year before was 774,558 bbl., and it is probable that the production for each year was about the same. The company has 239 wells, all but two being pumped by electric power. Six large and several small jacks are used. The use of electric power for pumping has decreased the consumption of fuel oil on the property from 108,710 to 33,413 barrels.

*5 ft. assumed to be divisional height between contours as advised above.

OPERATION OF DIESEL ENGINE IN MUNICIPAL ELECTRIC PLANT AT PALO ALTO, CALIFORNIA

The results of the first nine months' use of a Diesel engine in the municipal electric plant at Palo Alto was summarized in a paper presented at the annual convention of the League of California Municipalities by J. F. Byxbee, city engineer of Palo Alto. The plant furnishes light, power, and heat to about 1500 services. The average peak load is about 360 kilowatts, and the load factor is 40%. The steam-engines originally used at the plant gave a low efficiency as far as fuel oil was concerned, the average output being 1.75 kilowatt-hours per gallon. In order to increase the capacity of the plant and to replace one steam-engine that was worn out, a Koerting Diesel engine was purchased. It was placed in operation about December 1, 1914, and since then has carried the main load of the station.

In ordinary operation of the plant the engine delivers from nine to twelve kilowatt-hours at the switchboard per gallon of fuel oil. One at least of the steam-boilers is kept under pressure all the time to provide for breakdowns of the Diesel engine, to provide for any sudden increase in the load, and to furnish steam for the steam fire-pumps. In addition, a steam engine helps to carry the peak-load for from two to four hours in the evening. For these reasons the actual output of the station is brought down to about five kilowatt-hours per gallon of fuel oil; a fuel oil with a gravity of about 16° Baumé and a fuel value of 18,000 B.t.u. per lb. For starting, a lighter oil with a gravity of 24° Baumé is used. About five gallons of lubricating oil and 48,000 gallons of cooling-water are used per day. The Diesel engine has been found to be a little more expensive than a steam plant as regards lubricating oil and a little less as regards water, the two about balancing each other.

Repairs have been almost negligible, except for the regular cleaning of pistons and exhaust-valves. Each piston is cleaned once in four weeks, the usual practice being to shut the engine down for about eight hours each week, to clean one piston and two exhaust valves, and any other work that seems necessary. From December 1, 1914, to September 1, 1915, the engine operated 5980 hours, or 91% of the total time. Of the time the machine was shut down, 312 hours were for the regular cleaning-periods, and 284 hours for repairs. It may be noted that over half the time for repairs was during the first six weeks of operation.

The operating force at the plant is the same as before the Diesel engine was installed. The steam-engineers have had no difficulty in learning to operate the new engine. The machine is usually started and the load taken in three minutes. Allowing for the increased first cost of the Diesel engine, a considerable saving has been made over steam operation.

Goggles should be worn by men using emery wheels; and safety-collars should be fitted to the wheels to prevent them from bursting.

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The Use of Concrete for Protecting Wood-Stave Pipe

By KENNETH A. HERON*

At the present time there is more data available concerning the life of wood-stave pipe under varying conditions than there was ten or twelve years ago. Several pipe-lines placed at that time under favorable circumstances have since deteriorated to such a degree that expensive repairs and renewals have been required in order to keep them in operation. In two instances in my own experience it was found necessary to protect the wood pipe with a concrete covering.

St. Charles Canal. On the St. Charles canal near Pueblo, Colorado, there were originally three double lines of fir-stave pipes in the form of inverted syphons, ranging from 200 to 1200 ft. long. The head of these syphons ranged from 10 ft. to 60 ft. In 1908 it was found that after about six years of use, long sections had decayed to such an extent as to be in danger of failure. An examination of the pipes showed that the

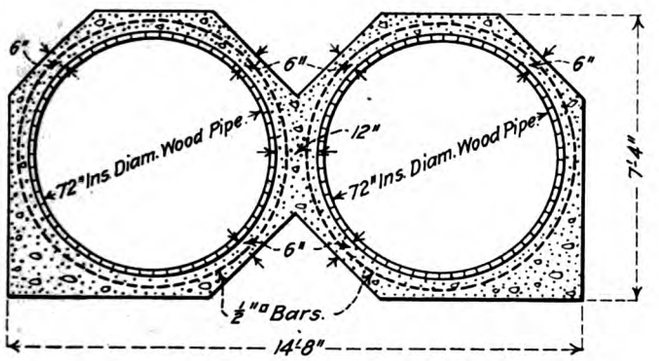

FIG. 1. CROSS-SECTION OF SYPHONS NO. 1 AND 3, ST. CHARLES CANAL.

interior had not been affected by decay except where it had reached nearly through from the outside. Instead of one or two bad staves rotting here and there, the affected parts consisted of round and oval areas from twelve inches to seven or eight feet in diameter. In some places the decay had progressed until a shell of sound wood ⅛ in. thick was all that was left. The pipe trench had been excavated in a lime shale and earth formation, and the best of this material had been used in the backfill. Several methods of replacing the pipe were suggested, but it was decided to use the wood pipe as it was except for some minor repairs, as the inside form for new reinforced concrete pipe. (Fig. 1.) As reconstructed, the concrete has a minimum thickness of 6 in. and is reinforced with ½-in. square twisted-bars spaced 12 in. centre to centre longitudinally, to provide for temperature stresses. The band spacing varies according to the head on the pipe, but is not greater than 12 in. centre to centre. The bands lap 12 in., and about 3 in. on the end of each rod is bent at right angles. The reinforcement was fabricated in semi-circular sections 12 ft. long and was wired together after placing. The pipe was cleaned and scraped before the steel was placed. Being empty it was easily supported on wood blocks which were pulled out as the concrete was poured. Concrete was run into the forms by chutes. A 1:3:5 mixture was used.

On syphon No. 1 the haul on the sand and gravel was from ¾ mile to a mile. On an average a team could haul eight loads per day. About 3/7 of the aggregate was rock that had to be screened. Cement was hauled 7½ miles. It took seven hours to make the round trip. From 30 to 50 sacks were hauled at a load. Teams cost $4 to $4.50 per day. The mixer was moved once. Chutes up to 300 ft. long were used to deliver the concrete. There was 612.92 cu. yd. of concrete in the syphon. The plans called for 69.78 lb. of reinforcing steel per cu. yd. of concrete, and 14,810 lb. additional steel was used. The contract price for the concrete was $5.25 per cu. yd. The contractor's costs were as follows:

Sand and gravel:			
Teams, 1.90 hours at	$0.45	$0.855	
Laborers, 1.84 hours at	0.20	0.368	
			$1.223
Cement:			
Teams, 0.88 hours at	0.45	0.396	
Laborers, 0.02 hours at	0.20	0.004	
			0.40
Forms:			
Teams, 0.12 hours at	0.45	0.054	
Laborers, 0.16 hours at	0.20	0.032	
Carpenter, 0.80 hours at	0.325	0.26	
Carpenter helper, 1.11 hours at	0.25	0.278	
			0.624
Steel:			
69.78 lb. at	0.0069		0.475
Mixing and placing:			
Fireman, 0.49 hours at	0.275	0.135	
Teams, 0.07 hours at	0.45	0.032	
Laborers, 1.77 hours at	0.20	0.354	
Foreman, 0.19 hours at	0.30	0.057	
Carpenter, 0.03 hours at	0.325	0.010	
Carpenter helper, 0.06 hours at	0.25	0.015	
			0.603
Fuel:			
Coal	...	0.01	
Gasoline	...	0.005	
			0.015
Grand total			$3.340

Leaving $1.91 per cu. yd. to cover depreciation on tools and plant, supervision, general overhead, and contractor's profit.

On syphon No. 2, the sand and gravel was hauled

*Irrigation engineer, Lakeview, Oregon.

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about 1¼ miles. Eight loads were hauled per day. One load of cement was hauled in five hours. The camp was kept at the same place as for syphon No. 2. The mixer was set up once and not moved. The contract price was $4.40 per cu. yd. The total yardage was 174.88, and 3696 lb. of extra steel was used. The contractor's costs were as follows:

Sand and gravel:			
Teams, 1.85 hours at	$0.45	$0.833	
Laborers, 1.41 hours at	0.20	0.282	
			$1.115
Cement:			
Teams, 0.91 hours at	0.45		0.410
Forms:			
Teams, 0.32 hours at	0.45	0.144	
Laborers, 0.72 hours at	0.20	0.144	
Carpenter, 0.61 hours at	0.30	0.183	
Carpenter helper, 0.58 hours at	0.25	0.145	
			0.616
Steel:			
73.07 lb. at	0.0075		0.548
Mixing and placing:			
Fireman, 0.56 hours at	0.275	0.154	
Team, 0.28 hours at	0.45	0.126	
Laborers, 0.02 hours at	0.20	0.604	
Foreman, 0.27 hours at	0.25	0.068	
			0.952
Fuel as for syphon No. 1			0.015
Grand total			$3.656

Leaving $0.744 per cu. yd. to cover depreciation on tools and plant, supervision, general overhead, and contractor's profit.

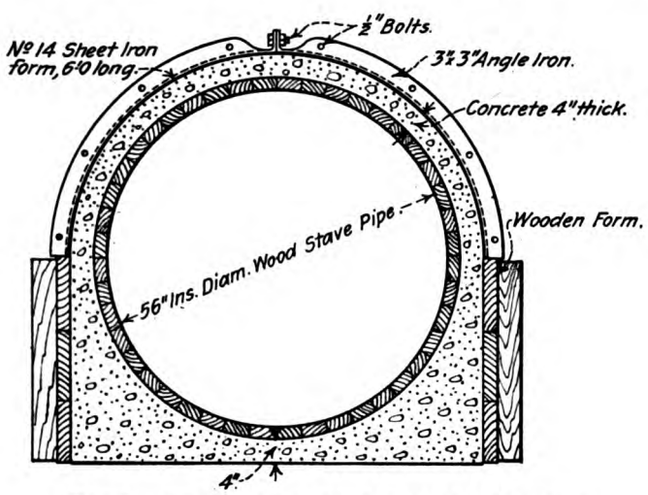

FIG. 2. CROSS-SECTION, ARKANSAS VALLEY CONDUIT.

A new camp was established for syphon No. 3 at a cost of $90. On all the syphons a ½ yd. cube-mixer was used. Sand and gravel were hauled about one mile, and the teams made eight or nine round trips per day. Cement was hauled 5½ miles. The mixer was set up on the bank and moved after each 100 ft. of syphon had been completed.

A 2-hp. Fairbanks-Morse & Co. gasoline engine was used to pump water to the mixer. About 500 ft. of 1-in. pipe was required. Two gallons of gasoline was used per day. The total yardage of concrete was 1220, and 21,053 lb. of extra steel was used. The contract price was $4.40 per cu. yd. The contractor's costs were as follows:

Sand and gravel:			
Teams, 1.38 hours at	$0.45	$0.621	
Laborers, 1.01 hours at	0.20	0.202	
			$0.823
Cement:			
Teams, 0.56 hours at	0.45	0.252	
Laborers, 0.07 hours at	0.20	0.014	
			0.266
Forms:			
Teams, 0.11 hours at	0.45	0.050	
Laborers, 0.14 hours at	0.20	0.028	
Carpenter, 1.61 hours at	0.30	0.483	
Carpenter helper, 0.43 hours at	0.225	0.097	
			0.658
Steel:			
69.78 lb. at	0.0064		0.447
Mixing and placing:			
Fireman, 0.50 hours at	0.275	0.138	
Teams, 0.12 hours at	0.45	0.054	
Laborers, 2.37 hours at	0.20	0.474	
Foreman, 0.19 hours at	0.30	0.057	
			0.723
Fuel same as for syphon No. 1			0.015
Grand total			$2.932

Leaving $1.468 per cu. yd. to cover depreciation on tools and plant, supervision, general overhead, and contractor's profit.

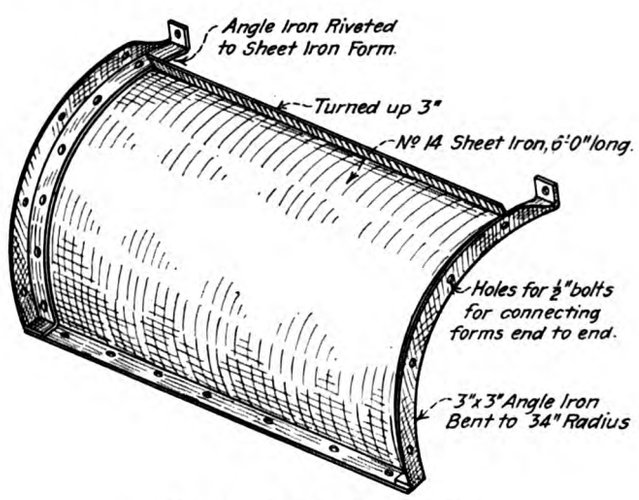
Angle Iron Riveted to Sheet Iron Form.
Turned up 3"
№14 Sheet Iron, 6'0" long.
Holes for ½" bolts for connecting forms end to end.
3"x3" Angle Iron Bent to 34" Radius

FIG. 3. SKETCH OF TOP FORM.

The cross-section for syphons No. 1 and 3 is shown in Fig. 1. The design called for approximately 30.24 cu. ft. of concrete per lin. ft. of conduit. The design for syphon No. 2 was similar except that there was a base of concrete 12 in. thick extending clear across. The total width was 15 ft. 4 in. and the total height 8 ft. 2 in. Where the head exceeded 20 ft. additional reinforcement was used. The total cost is summarized below. Excavation and backfill was done on force account. 'Final estimate' includes cost of hauling material, building forms, mixing and placing concrete, removing forms, etc.

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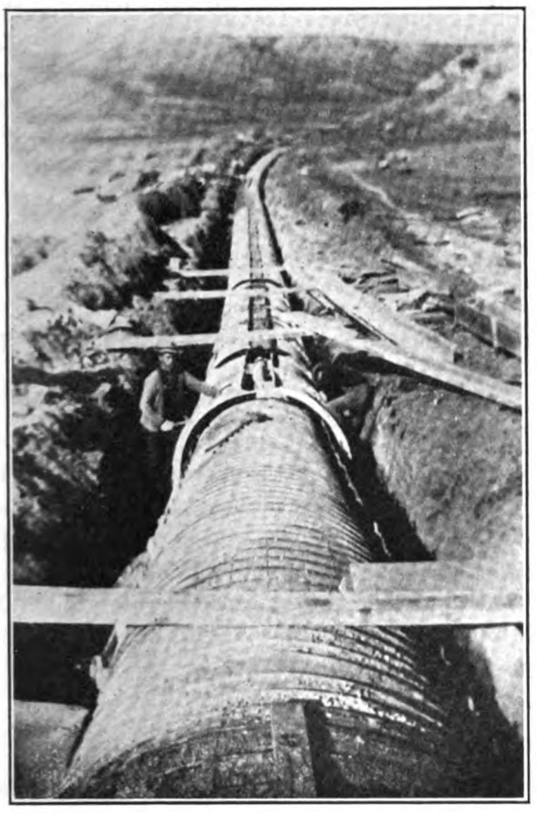
Cement:

	Syphon No. 1.	Syphon No. 2.	Syphon No. 3.
Testing	$ 6.38	$ 1.86	$ 11.94
Freight	36.78	11.00	69.00
Cost	1041.08	310.42	2101.21
Lumber	135.00	38.50	269.00
Steel	1355.96	309.81	2586.30
Nails, washers, etc.	42.31	12.10	85.42
Freight on lumber, nails, etc.	14.00	4.00	28.00
Force account	1538.34	498.59	2254.28
Final estimate	3366.35	805.82	5600.53
Inspection	245.00	69.00	487.75
Miscellaneous	.....	0.50	4.05
Total	$7781.20	$2061.60	$13,497.48
Approximate length	640 ft.	200 ft.	1200 ft.
Maximum head	40 ft.	10 ft.	60 ft.

On an average the new work cost $11.67 per foot of double pipe. This was a little less than the original cost of the wood pipe.

Arkansas Valley Conduit. Twenty or more pipes on the Arkansas Valley conduit (a canal on the same



ERECTING FORMS ON ARKANSAS VALLEY CONDUIT.

system) west of Pueblo, were subsequently encased in concrete for protection against decay which had already gained some headway. These pipes ranged in length from 200 ft. to over a mile and in diameter from 28 to 60 in. They were built in 1905-06. Fig. 2 shows a cross-section of a 56-in. pipe. The concrete was placed while the water was flowing in the pipes. In general the pipe was buried with from 18 in. to 2 ft. of earth cover when the work was started. This was removed down to the spring line of the pipe. Sections three or four feet wide were then excavated under the pipe about 15 ft. centre to centre. Concrete saddles about 3 feet long were poured at these places. When the concrete had hardened the excavation was completed. With these supports the pipe showed no distortion even under light heads. The concrete covering on a few of these pipes was reinforced with wire fabric and rods. A large part of the work, however, was done without reinforcing, the concrete being placed solely to preserve the wood pipe and bands. The concrete was 4 in. thick all around the pipe. The side-forms were wood as far as the springing-line. The top form was made of No. 14 sheet iron supported by 3 by 3-in. angle-ribs as shown in Fig. 3. The forms were made in 6-ft. sections with one rib on each end. They were fastened to the wooden forms on the sides and then braced to the pipe. About 30,000 lin. ft. of pipe was protected in this way. The contract price was $3.60 per cu. yd., the company furnishing the cement.

CONSTRUCTION OF ASPHALTIC MACADAM STREETS AT RICHMOND, CALIFORNIA

The use of the penetration method for constructing asphaltic macadam at Richmond, California, was described in a paper presented at the convention of the League of California Municipalities by H. D. Chapman, city engineer. The same kind of sub-grade is prepared as for water-bound or for oil macadam. On this sub-grade is placed eight inches of 2½-in., and upon the rock is spread a rock dust. This is rolled dry until the voids are practically filled, and then wet and rolled again. Another layer of dust is then placed on top, followed by a two-inch layer of 1½-in. rock. On this rock is spread a layer of asphaltum at the rate of one gallon per square yard of surface. For the Richmond streets, the E grade asphaltum from the nearby refinery of the Standard Oil Co. is used. This is rolled, the roller following immediately after the asphalt-sprayer. The wheels are kept wet all the time with water and there is no adhesion to the roller. A thin layer of rock, ranging from ¼ in. to ¾ in. is then spread longitudinally with the street and rolled until all the voids are filled, rock being added in small quantities until it can no longer be rolled into the asphalt. Upon this surface another layer of asphaltum is spread, using one gallon per square yard, and rolled as with the first asphaltum course. Another layer of ¼-in. rock is added. This last layer should have a little rock-dust with it. The other rock used should be clean. When this is rolled the street is finished.

The asphalt sprayer uses an 80-lb. pressure. Where the work is some distance from the base of supplies, a heater under the tank is advisable. Heating by steam is not satisfactory. A dart valve is used on the wagons. At Richmond, the cost for the pavement alone exclusive of grading, is 7½ to 10c. per sq. ft. Asphalt costs $6 per ton in tank cars or $11.50 in barrels. Some pavements constructed in this way have been in use for two years, and the results have been satisfactory.

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Costs of State-Highway Work in Vicinity of San Francisco*

Following are the principal items in the cost of construction of portions of the State highway between Oakland and San Jose and San Jose and San Francisco. Some parts of the highway have not been completed, and others are incorporated towns and were not built by the State. Except for the portion between Baden and Daly City, practically all the work was in level country.

Oakland to Hayward, 5.06 Miles

Pavement was completed in November 1914. Except for about ½ mile where the highway was relocated and a 5-in. concrete base laid, the pavement was laid on an old water-bound macadam road, 50 ft. between curbs and 7 in. thick. The pavement was 24 ft. wide and the cost per sq. yd. was as follows:

Repairing old macadam base	$0.022
Surfacing with 2-in. topeka top	0.696
Total	$0.718

The cost per mile for the macadam-base portion was as follows:

Structures	$ 291
Base	312
Surface	9,800
Total	$10,403

Hayward to Valle Vista School, 3.12 Miles

On this portion, a base of 1:2½:5 concrete, 4½ in. thick with a ⅜-in. asphaltic oil surface was used. The concrete was completed in October 1914, and the surface in July 1915. The road was graded 30 ft. wide. The earthwork was 2380 cu. yd. per mile, and cost $0.85 per cu. yd. The pavement was 18 ft. wide and the cost per sq. yd. was as follows:

Base	$0.743
Surface	0.076
Total	$0.819

The cost of the completed highway per mile was as follows:

Structures	$ 1,061
Grading	2,023
Base	7,850
Surface	803
Broken stone shoulders	2,335
Total	$14,072

Valle Vista School to Overacker, 6.21 miles

The same type of pavement was used as on the preceding portion. The concrete was finished in June, 1915, and the oil surface in August, 1915. The road was graded 30 ft. wide. The earthwork was 2721 cu. yd. per mile, and cost $0.905 per cu. yd. The pavement was 18 ft. wide and the cost per sq. yd. was as follows:

Base	$0.846
Surface	0.076
Total	$0.922

The cost of the completed highway per mile was as follows:

Structures	$ 477
Grading	2,463
Base	8,934
Surface	803
Total	$12,677

Alameda County Line to San Jose

The same base was used for the pavement as on the preceding portion. Cost data for the surfacing are not yet available. The concrete was completed in July, 1915. The grading was 30 ft. wide. The excavation was 1500 cu. yd. to the mile and cost $0.70 per cu. yd. The concrete base for the pavement cost $0.744 per sq. yd. The cost per mile of the highway was as follows:

Structures	$ 260
Grading	1,050
Base	7,859
Total	$9,169

From San Jose to Santa Clara, 1.93 miles, on 'The Alameda'

The width between curbs here is 74 ft. and the total width 115 ft. The State paid for all grading and 12 ft. of pavement on each side of street-car tracks. Santa Clara county and the property-owners paid for the rest of the work. The excavation was 13,600 cu. yd. per mile, and cost $0.59 per cu. yd. The pavement was composed of a 6-in. base of 1:3:6 concrete, and a 1½-in. topeka top, and the cost per sq. yd. was as follows:

Base	$0.681
Surface	0.470
Total	$1.151

A combination curb and gutter cost $0.56 per lin. ft. Sidewalks 3½ in. thick cost $0.105 per sq. ft. The cost per mile of the completed highway was as follows:

Structures	$ 176
Grading	8,024
Base and surface	36,587
Curbs and gutters	5,850
Sidewalks	11,969
Total	$62,606

Santa Clara to Lawrence, 1.15 miles

The pavement was the same type as that from Hayward to Valle Vista School. The concrete was completed in October, 1913, and the surface in September,

*Condensed from *Pacific Coast Good Roads.*

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1914. The grading was 30 ft. wide. The earthwork was 5250 cu. yd. per mile and cost $0.51 per cu. yd. The pavement was 20 ft. wide and the cost per sq. yd. was as follows:

Base	$0.645
Surface	0.094
Total	$0.739

The cost per mile of the completed highway was as follows:

Structures	$ 1,811
Grading	2,678
Base	7,568
Surface	1,103
Rock shoulders	1,930
Total	$15,090

Lawrence to Stevens Creek, 5.51 miles

Type of pavement and widths of grading and pavement were the same as for the preceding portion except that the base for the pavement was 4 in. thick. Earthwork was 1575 cu. yd. per mile. Pavement cost per sq. yd. was as follows:

Base	$0.600
Surface	0.095
Total	$0.695

The cost per mile of the completed highway was as follows:

Grading	$ 803
Base	7,090
Structures	1,120
Total	$9,013

Stevens Creek to Palo Alto, 6.44 miles

The pavement was composed of a 5-in. new macadam base with a 1½-in. topeka top. It was completed in July, 1914. The grading was 30 ft. wide. The earthwork was 1460 cu. yd. per mile and cost $0.41 per cu. yd. The pavement was 20 ft. wide and the cost per sq. yd. was as follows:

Base	$0.642
Surface	0.494
Total	$1.136

The cost per mile of the completed highway was as follows:

Structures	$ 226
Grading	599
Base	7,570
Surface	5,830
Stone shoulders	1,897
Total	$16,122

Approaches to San Francisquito Bridge, 0.26 mile

The pavement was composed of a 3½-in. asphaltic concrete base and an asphaltic concrete surface. It was completed in September, 1914. The grading was 36 ft. wide. The earthwork was 6750 cu. yd. per mile and cost $0.83 per cu. yd. The pavement was 20 ft. wide and the cost per sq. yd. was as follows:

Base	$1.60
Surface	0.71
Total	$2.31

San Francisquito Creek to Redwood City, 3.28 miles

The type of pavement and width of grading and pavement were the same as for the portion between Stevens Creek and Palo Alto. The pavement was completed in December, 1913. The earthwork was 1730 cu. yd. per mile and cost $0.42 per cu. yd. The cost of the pavement per cu. yd. was as follows:

Base	$0.648
Surface	0.588
Total	$1.236

The cost of the completed highway per mile was as follows:

Structures	$ 109
Grading	726
Base	7,715
Surface	7,000
Total	$15,550

Beresford to San Mateo, 1.76 miles

The type and width of pavement was the same as for the preceding portion, but the grading was 36 ft. wide instead of 30 ft. The earthwork was 2800 cu. yd. per mile and the cost was $0.45 per cu. yd. The pavement was completed in November, 1913. The cost of the pavement per sq. yd. was as follows:

Base	$0.643
Surface	0.550
Total	$1.193

The total cost per mile of the completed highway was as follows:

Structures	$ 775
Grading	1,260
Base	7,550
Surface	6,450
Total	$16,035

Hillsborough to Burlingame, 0.21 mile

The grading was 40 ft. wide. The pavement was composed of a 5-in. base of 1:3:6 concrete, and a 1½-in. topeka top. The pavement was 24 ft. wide and was completed in August, 1913. The grading was 10,900 cu. yd. per mile, and cost $0.50 per cu. yd. The cost of the pavement per sq. yd. was as follows:

Base	$0.71
Surface	0.50
Total	$1.21

Burlingame to Baden, 5.41 miles

The width of grading and pavement were the same as for the preceding portion, also the type of base for the pavement, but the wearing surface was standard

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sheet-asphalt 1-in. thick. The earthwork was 4220 cu. yd. per mile, and cost $0.37 per cu. yd. The cost of the pavement was as follows:

Base	$0.676
Surface	0.395
Total	$1.071

The cost per mile of the completed highway was as follows:

Structures	$ 578
Grading	1,561
Base	9,520
Surface	5,560
Total	$17,219

From Baden to Daly City, 4.04 miles

The grading was 40 ft. wide and 50 ft. along the railroad. The pavement was 24 ft. wide and was of the same type as that between Hillsborough and Burlingame. The pavement was completed in November, 1914. The earthwork was 20,000 cu. yd. per mile, and cost $0.40 per cu. yd. The cost of the pavement per cu. yd. was as follows:

Base	$0.627
Structures	0.490
Total	$1.117

The cost of the completed highway per mile was as follows:

Structures	$ 5,370
Grading	8,030
Temporary gravel surface	884
Base	8,970
Surface	7,010
Total	$30,264

From Daly City to San Francisco, 1.02 miles

The grading was 50 ft. wide. The width and type of pavement was the same as for the preceding portion. The pavement was completed in June, 1914. The earthwork was 3690 cu. yd. per mile and cost $0.90 per cu. yd. The cost of the pavement per sq. yd. was as follows:

Base	$0.631
Surface	0.450
Total	$1.081

The cost of the completed highway per mile was as follows:

Structures	$ 1,028
Grading	3,321
Base	9,332
Surface	6,660
Total	$20,341

The highway immediately south of San Francisco, and in fact as far as San Jose carries a heavy traffic. On a pleasant Sunday as many as 15,000 automobiles pass a given point in ten hours.

MEXICAN OIL PRODUCTION

During the week of September 9, one of the biggest gushers in the Mexican fields was brought in by George Harmon. The well is in the Panuco field less than 100 ft. from the big Dutch-Shell gusher which has an estimated production of 100,000 bbl. per day. The oil was struck at a depth of 2120 ft., or 314 ft. deeper than the Dutch-Shell well. As a 55,000 bbl. tank had already been constructed on the lease, all the oil was saved and accurate gauge of the well was made. In about 15 hours the tank was filled and the well was shut in without any leakage. This well is estimated as being capable of producing 90,000 bbl. per day. A decree was issued on August 14 prohibiting oil companies from drilling for the production of crude oil within 30 metres (98½ ft.) of the boundaries of their lands. It is understood that this decree will not be retro-active and, consequently, will not affect the wells now being drilled within the 30-metre zone.

The shipments of crude oil from Tampico to United States ports during September amounted to 809,728 bbl., as compared with 951,589 bbl. during September of the preceding year. This decrease was due to a great extent to the conditions of the harbor. The heavy sea caused by the recent hurricanes in the Gulf, combined with a freshet in the Panuco river, caused a sand bar to be formed about 165 ft. from the end of the jetties on which there is only about 19 ft. of water. The Huasteca tanker *Charles E. Harwood* was the first steamer to leave after the storm and struck the bar, drawing 21 ft. The stern post was bent, and several blades were broken off the propeller. After pumping about 5000 bbl. of oil overboard, the steamer was floated and towed back to Tampico.

THE EFFICIENCY EXPERT

The devil opened the furnace door
And heaved in a shovel of coal,
When out there popped on the scorching floor
A truculent, half-baked soul.
"Look here, good devil," it said, "I pray
You will pardon my seeming haste,
I am—you must listen to what I say—
Appalled at your awful waste!

"Two-thirds of your heat goes up the flue,
Your coal is but half consumed;
If a modern plant should compete with you
This business were surely doomed.
Your times and motions I've studied well,
As you hustle the sinners in,
And I find you have here but a third-rate hell
For the way it is run is a sin!"

The devil grabbed up that critic then
With an angry shake and a flirt,
And said "Go back to the world of men,
You efficiency expert!
If you stay down here you will get my job,"
(Here he uttered a dismal groan),
"But if you go" (here he gave a sob),
"You will fix up a hell of your own!"

—*Chicago News.*

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The Design of Reinforced Concrete Tee-Beams

By H. DEVEREUX*

The design and investigation of a tee-beam as outlined in the text books is complicated and is a mystery to many, because it is difficult to reason in millions of inch pounds. The following rules have been devised so that a layman may intelligently discuss a tee-beam with the aid of a piece of chalk and a shingle. The usual notations and the San Francisco building laws have been followed:

Shear in concrete, 100 lb. per sq. in.
Tension in steel, 16,000 lb. per sq. in.
Compression in concrete, 500 lb. per sq. in.
n = 15.
w = load in tons per lin. ft. of beam.
W = total uniform load on beam in tons.
L = span in feet.
b = required width of flange in inches.
b' = width of stem in inches.
d' = depth of stem in inches = arm of resisting couple.
t = thickness of slab.
A_s = area of steel in sq. in.
A_c = area of stem in sq. in. (the part below slab)
F_s = stress in steel in lb. per sq. in.
F_c = stress in concrete in lb. per sq. in.
A' = area of steel in top of beam.
a' = area in sq. in. that flange is deficient in order to offset A_s.

Equations:

(1) $L = \frac{A_c}{10w}$

(2) $W = \frac{A_c}{10}$

(3) $A_c = 10W$

(4) $A_s = \frac{3WL}{20d'}$

(5) $M = \frac{WL}{10}$

(6) $b = \frac{64A_s}{t}$

(7) $A_c = b'd'$

(8) $A' = \frac{a'}{24}$

(9) $F_s = \frac{24{,}000M}{A_s d} = \frac{2400WL}{A_s d'}$

(10) $F_c = \frac{2 \times 16{,}000A_s}{bt}$

(11) A' = 1.9 excess of steel in stem.

The average shear in a beam is generally taken as $b'd$. Here, $b'(d-\frac{1}{2}t)$ is used and $\frac{100\,b't}{2}$ is considered as equal to the shear due to the weight of the beam. Therefore W may be considered as the live load.

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(12) For $M = \frac{WL}{8}$ L = 3/4 of span as figured.

(13) For $M = \frac{WL}{12}$ L = 9/8 of span as figured.

(14) M in foot-tons $= \frac{A_s \times 16{,}000 \times (d-\frac{1}{2}t)}{12 \times 2000} = \frac{2A_s d'}{3} = \frac{WL}{10}$ and $A_s = \frac{3WL}{20d'}$

(15) Where b is not greater than $\frac{1}{4}$ of the span or $10t + b'$ or $\frac{2}{3}$ of distance between adjacent beams.

(16) $A_s = \frac{3WL}{20d'}$ $L = \frac{20A_s d'}{3W}$ $W = \frac{20A_s d'}{3L}$ $d' = \frac{3WL}{20A_s}$

$M = \frac{2A_s d'}{3}$ $d' = \frac{3M}{2A_s}$

Example: A tee-beam has the following dimensions: b = 48 in., t = 4 in., d' = 16 in., b' = 10 in. Steel consists of six $\frac{3}{4}$-in. round rods. If the working strength of steel is 16,000 lb. and of concrete, 500 lb. per sq. in., what is the safe load in tons and the span in feet? Six $\frac{3}{4}$-in. round rods have an area of 2.65 square inches.

From (2) $W = \frac{10 \times 16}{10}$ = 16 tons.

(16) $L = 20 \times 2.65 \times \frac{16}{3} \times 16 = 17.6$ ft.

(6) $b = \frac{64 \times 2.65}{4} = 42.5$ in.

Suppose diameter of rods is 1 in. and M = 50 foot-tons.
$A_s = 6 \times 0.7854 = 4.7$ sq. in. t = 6 in.

(5) $50 = \frac{16 \times L}{10}$ and $L = 31.25$ ft.

(9) $F_s = \frac{24{,}000 \times 50}{4.7 \times 16} = 16{,}000$ lb.

(10) $F_c = \frac{2 \times 16{,}000 \times 4.7}{58 \times 6} = 430$ lb.

The flange of a tee-beam is 24 in. wide and 4 in. thick. The bending moment is 20 foot-tons. What depth of beam and what area of steel will be needed?

(6) $b = \frac{64A_s}{t}$ $24 \times 4 = 64\ A_s$. $A_s = 1.5$ sq. in.

(16) $d' = \frac{3M}{2A_s} = \frac{3 \times 20}{2 \times 1.5} = 20$ in.

For comparing a reinforced concrete tee-beam with beams of other kinds, the following formulæ may be used:

For a steel I-beam or channel:

Safe uniform load in tons = $\frac{\text{Weight of beam times depth in inches}}{\text{2 times span in feet}}$

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Tee Beam and Girder Table

H. DEVEREUX. S.F.'15.

Load per Lin. Ft. in Tons, Span in Feet, Area of Steel & Reinforcement.

No	Slab in	Nominal size on Plan	Size of Stem using Sized Lumber	Cu. ft. Conc. in Stem	Nominal size of Lumber used		3/4 Ton L	3/4 Ton As	1 Ton L	1 Ton As	1 1/4 Tons L	1 1/4 Tons As	1 1/2 Tons L	1 1/2 Tons As	2 Tons L	2 Tons As	3 Tons L	3 Tons As	4 Tons L	4 Tons As	5 Tons L	5 Tons As
					In bottom SIZE	1 Side SIS																
Beams.																						
a	3½"	6 x 12"	5½ x 8¾	.34	2 x 6	2 x 10	6¾	0.56	5	0.42												
							3 - 1/2		2 - 1/2													
b		" x 15"	" x 10¾	.42	"	2 x 12	8	0.67	6	0.50												
							3 - 1/2		2 - 1/2													
c	4"	8 x 13½	7½ x 8¾	.46	2 x 8	2 x 10	8½	0.85	6½	0.75	5	0.6										
							4 - 1/2		3 - 1/2		3 - 1/2											
d		" x 15½	" x 10¾	.56	"	2 x 12	10½	1.2	8	0.9	6½	0.75	5½	0.65								
							2-1/2	2-5/8	4 - 1/2		3 - 1/2		3 - 1/2									
e		" x 17½	" x 12¾	.67	"	2 x 14	13	1.5	9½	1.1	7½	0.85	6½	0.75								
							4 - 5/8		2-1/2	2-5/8	4 - 1/2		3 - 1/2									
f		" x 19	" x 14¼	.75	"	2-2 x 8	15	1.8	11	1.25	9	1.0	7½	0.85	5½	0.62						
							2-5/8	2-3/4	2-1/2	2-5/8	4 - 1/2		4 - 1/2		3 - 1/2							
g		" x 21	" x 16¼	.85	"	1-2 x 8	16½	1.9	12½	1.4	10	1.12	8½	0.95	6¼	0.7						
						1-2 x 10	2-5/8	2-3/4	4 - 5/8		2-1/2	2-5/8	4 - 1/2		3 - 1/2							
Girders.																						
1	5"	10 x 22	9½ x 16¼	1.07	2 x 10	1-2 x 8	21	3.25	16	2.3	13	1.85	11	1.6	8	1.15						
						1-2 x 10	6 - 3/4		4 - 3/4		2-4/8	2-3/4	4 - 5/8		2-1/2	2-5/8						
2		" x 24	" x 18¼	1.20	"	2-2 x 10	24	3.35	18	2.6	14½	2.1	12	1.7	9	1.3						
							6 - 3/4		2-3/4	2-7/8	4 - 3/4		2-5/8	2-3/4	2-1/2	2-5/8						
3		" x 26	" x 20½	1.34	"	1-2 x 10	25½	3.65	19	3.0	15	2.15	13	1.85	9½	1.35						
						1-2 x 12	4-3/4	2-7/8	4 - 7/8		2-3/4	2-7/8	2-5/8	2-3/4	4 - 5/8							
4		12 x 24	11½ x 18¼	1.45	2 x 12	2-2 x 10	28	4.85	21	3.6	17	3.0	14	2.5	10½	1.8	7	1.2	5	0.9		
							4-7/8	2-1	4-3/4	2-7/8	4 - 7/8		2-3/4	2-7/8	2-5/8	2-3/4	2-1/2	2-5/8	4 - 1/2			
5		" x 26	" x 20¼	1.68	"	1-2 x 10	31	5.3	23	4.0	18½	3.2	15	2.6	11½	2.0	7½	1.3	6	1.05		
						1-2 x 12	3-7/8	3-1	2-3/4	4-7/8	6 - 3/4		2-3/4	2-7/8	4 - 3/4		2-1/2	2-5/8	4 - 1/2			
6		" x 28	" x 22¼	1.80	"	2-2 x 12	34	5.9	26	4.6	21	3.6	17	3.0	13	2.25	8¾	1.6	7	1.2		
							8 - 7/8		6 - 7/8		4-3/4	2-7/8	4 - 7/8		4 - 3/4		4 - 5/8		2-1/2	2-5/8		
7	6"	14 x 32	13½ x 26	2.44	2 x 14	2-1 x 10	2 x 4 - 3'0"		35	7.0	28	5.7	23	4.6	17½	3.5	12	2.4	8	1.6		
						1-1 x 8	4'0" C. C.		4-7/8	4-1	4-1	2-7/8	6 - 7/8		2-7/8	2-1	2-3/4	2-7/8	4 - 5/8			
8		" x 34	" x 28	2.63	"	3-1 x 10	Do				30	6.0	25	5.0	19	3.85	12½	2.5	9	1.8		
											6 - 1"		4-7/8	2-1"	3-3/4	3-7/8	2-3/4	2-7/8	2-5/8	2-3/4		
9		" x 36	" x 30	2.82	"	4-1 x 8	"				32	6.5	27	5.5	20	4.0	13	2.65	10	2.0	8	1.6
											4-1	2-7/8	4-1	2-7/8	3-3/4	3-7/8	2-3/4	2-7/8	4 - 3/4		4 - 5/8	
10		" x 38	" x 32	3.00	"	2-1 x 8	"				34½	7.0	29	6.0	22	4.5	15	3.0	11	2.25	9	1.8
						2-1 x 10					4-7/8	4-1"	8 - 7/8		8 - 3/4		6 - 3/4		4 - 3/4		2-5/8	2-3/4
11		15 x 42	15 x 36	3.75	2-2 x 8	4-1 x 10	2 x 4 - 4'0"						34	7.3	27	6.0	18	4.0	13	3.0	11	2.5
							3'6" C. C.						6-1"	2-7/8	8 - 7/8		3-3/4	3-7/8	4 - 7/8		2-3/4	2-7/8

A_c = bd' in inches.
W = Load in Tons.
L = Span in Feet.
A_s = Area Steel in Sq.ins.
Shear 100 # Comp. 500 # Tension 18000 # Sq.ins.
M = WL/10
A_c = 10 W
A_s = 3WL/20d'
bt = 64 A_s
d' = 3WL/20 A_s
L = 20 A_sd'/3W
W = 20 A_sd/3L
M = 2 A_sd'/3
d' = 3M/2 A_s.

For an Oregon pine beam:

Safe uniform load in tons =

$$\frac{\text{Area in sq. in. times depth in inches}}{\text{15 times span in feet}}$$

The beam and girder table gives maximum spans for 100 lb. per sq. in. shear in concrete, and maximum steel areas for 500 lb. compression for concrete in flange with b not greater than $10t + b'$ or $\frac{1}{4}$ the span. The working stress for steel is taken as 16,000 lb. per square inch.

To use the table, under load in tons per lin. ft., find span and area of steel. Below the span find selection of square steel, read size of stem and size of beam.

Example: With a 2-ton load per lin. ft. and a 13-ft. span, to find area of steel, size of beam and selection of steel.

Solution: Under 2 tons at 13 ft., read area of steel, 2.25 sq. in., requiring four 3-in. square bars. On same line to left read 11½ by 22¼ stem or a 12 by 28-in. beam.

Example 2: Find the safe load on a 10 by 26-in. beam with a 19-ft. span. Find also area of steel and selection of bars.

Solution: On same line as 10 by 26-in., under 1-ton load at 19 ft. Safe load = 19 × 1 = 19 tons. Use four $\frac{7}{8}$-in. square bars.

Example 3: Find area of steel and safe span for a 5-ton load on a 15 by 42-in. beam.

Solution: On same line as 15 by 42-in. under 5 tons read 11-ft. span 2.5 sq. in. Use two $\frac{3}{4}$-in. and two $\frac{7}{8}$-in. square bars.

For supported beams in the above table, decrease span 10%. For continuous beams, increase span 10%.

HIGHWAY CONSTRUCTION BY CONVICT LABOR IN COLORADO

The use of convict labor on road construction was discussed before the Pan-American Road Congress by J. E. Maloney, engineer for the State Highway Commission of Colorado. Convicts have been employed on road work since 1899. A road camp may have anywhere from 25 to 75 convicts, under a superintendent and foreman. Although the law provides for the expense of armed guards, none have been employed since 1907. Less than 1% of the men attempt to escape.

During the two years 1913 and 1914, 140 miles of highway has been built by convicts. As a large part of the work was not accurately cross-sectioned, it is impossible to compute the cost of the work per cubic yard. The cost per man per day in camp was from $0.77 to $1.50, and it is believed that the efficiency of convict labor is nearly as great as free labor. The employment of convict labor probably saves the State and counties from 25 to 50% on the cost of the roads. Convict labor is especially suitable for rough side-hill work, where few teams are required.

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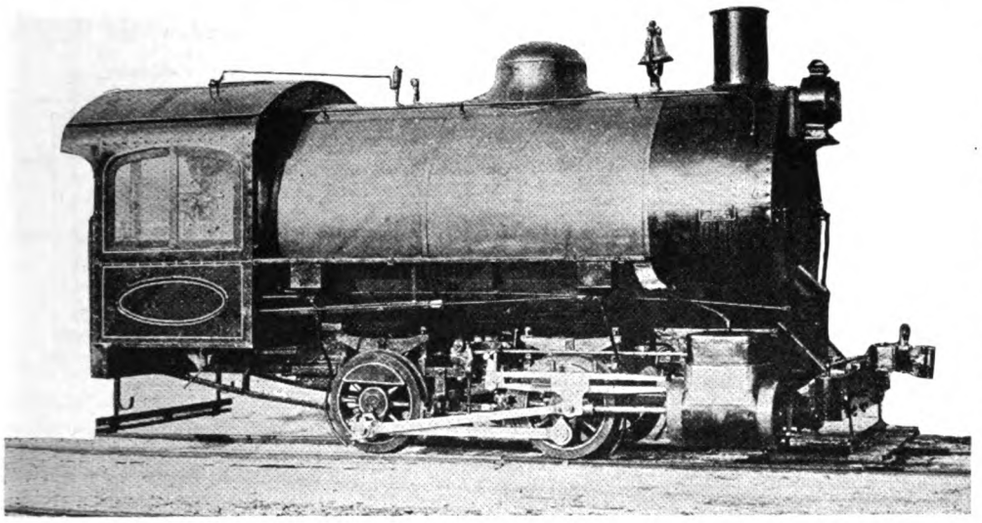
Fireless Locomotives

An account of a new type of switching locomotive constructed for use at the plant of the National Cash Register Co. by the Lima Locomotive Corporation, is given by W. A. Blum in *The Dodge Idea*. This type of locomotive differs from the ordinary, in being without a boiler and having no means of firing. It consists essentially of a large tank, seven feet in diameter and sixteen feet long, fitted only with such apparatus as is required for the control of the flow of steam to the cylinders. The capacity of the tank is 530 cu. ft. A thirty-inch steel dome is mounted on the tank. Inside of the dome the usual form of throttle-valve is placed,



VIEW OF LOCOMOTIVE.

from which a four-inch steam pipe leads through a reducing valve to the steam chests.

For the purpose of reducing as much as possible the surging of the water from one end to the other and the resulting disturbance of the equalization of the weight on the drivers, three large ⅜-in. steel baffle-plates with restricted openings are placed within the tank. In this way undesirable rocking of the engine is avoided. A 2-in. magnesia insulation is used on the outside of the tank to reduce the loss from radiation as much as possible, over which is placed the usual metal lagging.

Compressed-air tanks, suspended under the running-boards and charged from the plant equipment, are used to operate the automatic bell-ringer, the sand-distribution and the emergency-brake (ordinarily a powerful hand brake is used). An Edison storage-battery furnishes the current for the electric head-lights.

In preparing the engine for operation, the practice is to fill the tank about half-full of water, after which steam from the power-plant is admitted to the tank through a 2-in. perforated charging-pipe placed well below the water-level. By the time the pressure between the boiler-plant and the locomotive (about 150 lb.) is equalized, the water-level in the tank will be considerably raised and its temperature will be nearly equal to that of the steam by which it is charged, or about 370° F. The pressure at the cylinders is reduced to about 60 or 65 pounds per square inch by means of a reducing-valve, the cylinders being made sufficiently large, 18 in. diam. by 18-in. stroke.

As the steam is used, the pressure in the tank becomes less, allowing the water to evaporate gradually and maintain a steam-supply until it has been depleted to the point where it is no longer effective. The period of service available for one charge of the engine varies from two to three hours, depending, of course, on the number and weight of cars handled. The large diameter of the cylinders makes it possible to move the engine under its own power at low pressure, which enables the engine to return to the power-house for recharging, even though its capacity for doing effective work has been exhausted. It requires about 20 minutes for charging.

The exhaust from the cylinders is carried out through the stack, resembling closely the usual type for small locomotives in which there is mounted an exhaust head for the purpose of extracting the water of condensation from the vapor before being discharged to the atmosphere. The wheel-base of the engine is 72 in., the diameter of the wheels is 36 in. and the total weight when fully charged is about 77,500 lb., all of which, of course, is on the drivers.

These engines are used for switching purposes on more than two miles of track about the factory and are economical, in requiring but one man to operate them. The steam for them is generated in the central boiler-plant under the best conditions.

Increasing the production of old oil-wells by forcing air down one of the wells, is being tried in parts of West Virginia, according to the *Oil City Derrick*. This forces the oil to the adjacent wells. In one case a well that had been making less than a barrel per day was brought up to eight barrels by this method, and other wells have had their production increased 200 or 300%. One objection to the use of this method is that it is a patented process and a comparatively large royalty is required.

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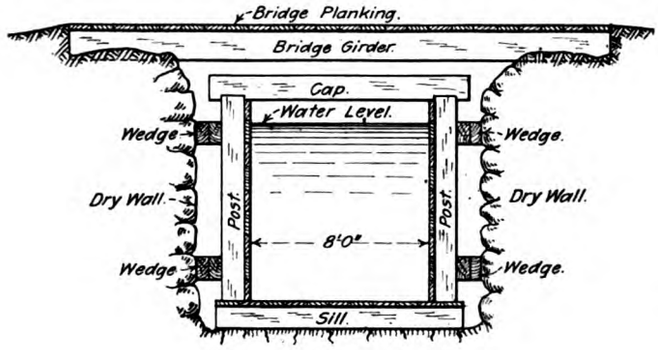
Methods of Repairing Decayed Wooden Flume

By P. B. McDONALD*

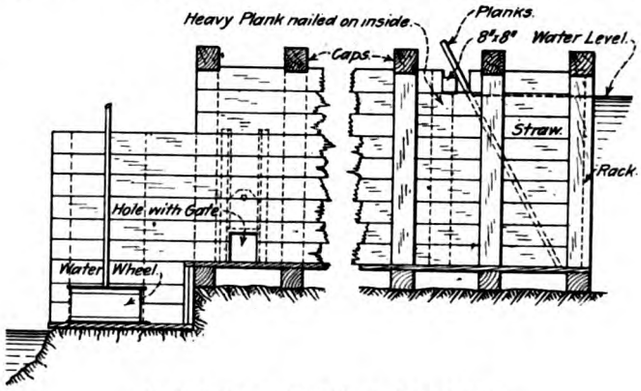
Not infrequently it happens that a mine or mill is driven by water-power, and when the place has been closed down for some time, the water-power development, if of wood, deteriorates very rapidly. A timber flume or penstock not in use seems to go to pieces about four times as fast as when being used, so that usually it is found, when it is desired to start up an old water-wheel, that there is considerable repairing necessary and much rotten timber to be replaced. The sketch shows the cross-section of such a flume in which nearly all the caps had decayed, allowing the posts to spread, due to the pressure of the water which had been forcing the walls of the flume outward during the time the mill had been shut down. In addition, several of the posts were rotten and needed to be replaced. But the especially bothersome part of it was that there were no head-gates to shut the water out of the flume, merely a rock at the up-river end of the flume for catching sticks and rubbish.



CROSS-SECTION OF FLUME.

The method used for shutting out the water in this particular instance was to saw a slot in each side of the flume deep enough to hold an 8 by 8-in. cross-timber, about 5 ft. back of the rock. To help the rather shaky walls of the flume to support this heavy timber, a plank with a notched end was nailed to the inside of each flume-wall under the timber. Then planks were put down in the water at an angle over the edge of this timber, choosing well-matched ones, so that their ends came nearly to the bottom of the rock. These planks were placed carefully to form as tight a joint as possible. Over one or two of the worst cracks, inch boards were placed. The planks were held in place by one nail through each one into the 8 by 8-in. timber. It had been discovered that the gate of the water-wheel could not be raised, as it had got rusted shut, so to drain the water from the flume a hole had to be cut in the down-river end of the flume close to the bottom. When this was done, it was first arranged so that if for any reason it became necessary to shut the water off quickly at this hole, it could be done by a plank sliding in two cleats on the outside of the flume just over the hole. After the hole was cut and opened, it was found that the coffer-dam did not leak badly in spite of the rather heavy pressure of the large mill-pond behind it. To make it more water-tight, several armfuls of straw were thrown in between the coffer-dam and the rock. The suction soon drew this into the cracks remaining between the planks.

It was decided not to replace the rotten caps, but to replace what posts were necessary and wedge them by short blocks of heavy timber between the posts and the stone dry-wall which was only a foot back of the posts. Had it been desired to make it still stronger, iron bolts could have been put across the flume from post to post, drawing them together. It is likely that it would have been found difficult to get long bolts in the flume because of the constricted space due to the flume being set in the ground with walls on each side. Incidentally, if it is ever desired to make the flume really permanent, all the timber will be removed, and the stone dry-walls already in place will be plastered with cement, making a comparatively cheap concrete flume, needing no re-inforcing and requiring forms only for one side. A concrete flume with its everlasting qualities is best appreciated by a man who has had to repair and maintain a second-hand wooden one.



LONGITUDINAL SECTION ALONG FLUME.

In the plant above described, it was further found that in addition to the gate on the wheel being rusted shut, the water-wheel shaft would not turn, due to rusting and non-use, so that a lot of 'back-breaking' tugging and trying, supplemented by loosening stuffing-boxes, chipping rust, etc., was necessary. In the work involved in overhauling an old water-wheel mill, it is difficult, as a rule, to get a good man to look after it, as a carpenter usually knows little of such things and many of them are afraid of the water and dislike getting wet.

*Mining engineer, San Francisco.

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Engineers' Note Book

FORMULA FOR DETERMINING DISCHARGE OF OIL PIPE-LINES

The following formula is taken from an article in *Engineering News* on Pumping California Crude Oil, by C. P. Bowie. It is considered to be reasonably accurate for oils with a gravity of from 16 to 28° Baumé and for pipe-lines from 12 to 20 miles long, and from 4 to 10-in. diameter.

Where Q is the quantity of oil in barrels per hour

C is a constant

P is the initial pump pressure (plus or minus the static head between terminals) in pounds per square inch.

L is the length of the line in miles

e is a factor dependent upon the size of the pipe used

Then $Q = C\sqrt{\frac{P}{L\,e}}$

For values of C use the following:

Gravity of oil.	Outgoing temperature.	Value of C.
16°B.	142°F.	160
18°B.	136°F.	167
20°B.	130°F.	174
22°B.	125°F.	183
24°B.	119°F.	192
26°B.	113°F.	202
28°B.	107°F.	213

For values of e use:

4-in. pipe	32.00
6-in. "	4.20
8-in. "	1.00
10-in. "	0.333

The temperatures given are the best shipping temperatures of the various oils and are lower for the lighter oils on account of the greater proportion of volatile matter they contain. The portion of a pipe-line between any two pumping stations may be considered as a separate line in itself. As this is usually between the given limit of 12 and 20 miles, and since practically all the pipe used is between 4 and 10 in., the formula covers most California practice except for oils below 16° gravity. Most of these are either transported in tank-cars, or in rifled pipe-lines, to which different formulæ are applicable.

As the friction losses in pumping of any given oil are mainly dependent upon the viscosity, rather than the gravity, exact results are not to be expected. However it should be sufficiently accurate for the computation of the number of pumping stations needed on a pipe-line, and of the spacing of these stations.

Hints on Practice

SPLICING BELTS

The following notes on belt-splicing are taken from *The Black Diamond* and apply to four-ply rubber belting. It is assumed, first, that the minimum belt-pulley diameter in inches is six times the number of plys in the belt, or 24 in. for a four-ply belt, and second, that in case special clips or fasteners are used, they are to be curved to the diameter of the pulley.

A butt-lap splice, in which a portion of the belt is used for making the lap joint, is satisfactory as far as strength goes. When properly made it develops nearly the strength of the original belt. The thickness of the belt, however, has been increased at the joint, from four to eight plys. Instead of a 24-in. pulley the diameter should be 48 in. The result is that every time this eight-ply belt passes over the 24-in. pulley the bending stress or power required to curve this extra thickness of belt around the pulley is increased. This causes a loss of power and increases the total power required. This loss may seem small, but in a plant with fifty or more belts running 3000 ft. per minute, the loss becomes important. Furthermore, should this belt have a reversed bend over the carrying or stress-pulley the splice cannot be used on account of the inability of the lap to ride smoothly over the stress-pulley.

The use of belt-clips or hooks is not recommended except for a quick and temporary repair. Such joints do not develop the full strength of the belt, but the ease of applying the clips warrants their use when the time required for making another form of splice would cause a serious delay. Since the curve of the clip is made to conform to the radius of the pulley, the additional bending stress in passing over the pulley, due to the thicker section of the belt at the splice, is eliminated. Like the butt-lap splice, this one cannot be used reversed over a stress or carrying-pulley.

The clamped-joint splice has only two claims to recommend it. It will develop approximately the strength of the original belt, and will run smoothly over the pulley without increasing the bending stress in the belt. Like the first two splices, it cannot run over reversed-belt pulleys. The 'bend' also is hard on the belt and is often the cause of future failures.

There is a loss of power in this splice, due to the splice cutting through or fanning the air. For example: Take a 16-in. belt running at 4000 ft. per minute with a splice projecting 2 in. high. Four thousand feet per minute is equal to 45 miles per hour. This gives a wind pressure of 12 lb. per square foot. The area exposed to this wind pressure of 12 lb. is 0.22 sq. ft. Figured in horse-power this loss equals:

$$\frac{0.22 \times 12 \times 4000}{33{,}000} = 0.32 \text{ hp.}$$

If there are many belts with this kind of splice the total loss will be considerable. This loss also occurs with the butt-lap splice and is directly proportional to the exposed area and velocity.

The hinged splice is probably one of the best splices for all general purposes. The construction of the splice is such as to bring the hinge or bend-point of the splice on the approximate neutral axis of the belt. This permits the splice to pass over the pulley without increasing the resistance because of increased bending stresses. The splice may be bent in either direction, consequently the belt may have reversed bends or run over stress-pulleys. The objection to this splice is that it does not develop the strength of the original belt. The belt therefore should be wide enough to allow for the efficiency of the splice.

There are other methods of belt-splicing, such as lacing and lap-splices. Both of these methods are desirable, and especially so when a flexible joint is required due to the diameter of the pulley being less than the ratio given above. The foregoing rule for the diameter of the pulley in relation to the plys of the belt is recommended for general use, though in extreme cases the ratio may be reduced to four to one.

In conclusion, the following may be stated: For large and permanent belt-drives, use the butt-lap splice, with cement for joints and copper rivets or belt-bolts. For light drives, where the belt width is sufficient, use the hinged-joint splice or rawhide lacings.

Book Reviews

IRRIGATION PRACTICE AND ENGINEERING. By B. A. Etcheverry. Volume II. Conveyance of Water. P. 354. Ill, index. McGraw-Hill Book Co., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $3.50.

The first volume of this work on 'Use of Irrigation Water and Irrigation Practice,' was reviewed in WESTERN ENGINEER-

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ING for October 1915. The present volume considers canals, pipe-lines, etc., in distinction to Volume III, which is to deal with irrigation structures. The first two chapters discuss the preliminary investigations and surveys for an irrigation project. Formulæ for flow of water in canals and pipes are then considered, particular attention being paid to the value of n in Kutter's formula for various types of canals. The deposition of silt and seepage and other conveyance losses are then discussed. A chapter is devoted to the design of canal cross-sections. Canal linings are then considered, a large amount of data on the cost of the different kinds of linings, particularly cement and concrete, being given. The next chapter takes up such special structures as tunnels, retaining walls and bench flumes. Wooden, steel, and reinforced concrete flumes are then considered, and the last chapter is devoted to the various kinds of pipe used in irrigation work. Considerable cost data is given in various parts of the volume. The book is well illustrated and will be of great value to irrigation engineers.

IMPERIAL VALLEY AND SALTON SINK. By H. T. Cory. P. 438. Ill. John J. Newbegin, San Francisco. For sale by the MINING AND SCIENTIFIC PRESS. Price, $3.50.

The transformation of the Imperial Valley from a worthless desert into a cultivated region with an assessed valuation of many millions is one of the most interesting as well as one of the most romantic episodes in California history. Now that the Imperial Valley irrigation district is established on a reasonably firm financial basis and the other troubles of the valley are well on their way toward solution, it is fitting that a history of the project should be published. The main part of the book is Mr. Cory's paper presented before the American Society of Civil Engineers in January 1913, together with the discussion that followed its presentation. There is also, however, a description of the region at the head of the Gulf of California, by the late William P. Blake, who while connected with the Pacific Railroad surveys in 1853, made the first scientific study of the region. Then follows a summary of various facts regarding the region, abstracted by the author from various scientific monographs, also a description of the watershed of the Colorado river. The reprint of Mr. Cory's paper follows. As most engineers will remember, this paper discussed the shortage of water that induced the California Development Co. to make the cut that it seemed for a time would result in permanently diverting the Colorado river. The paper then describes the various unsuccessful attempts to close the break and the final closing, together with the means taken to prevent a recurrence of the trouble. Most of the men who were connected with the work itself as well as many other prominent engineers, participated in the discussion of the paper. In closing, the author summarizes the events that have taken place since the appearance of the paper.

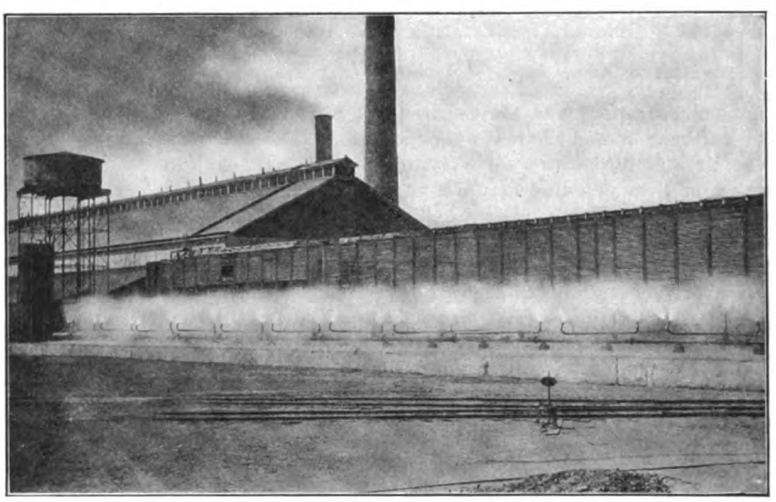
DIESEL ENGINES. Marine and Stationary. By A. H. Goldingham. P. 206. Ill., plan, index. Spon & Chamberlain, New York, 1915. For sale by the MINING AND SCIENTIFIC PRESS. Price, $3.

In the Palace of Machinery at the Panama-Pacific Exposition a 500-hp. Diesel engine, direct connected to a 250-kw. generator, was run for 10 months at a cost of 68 cents per hour. Crude California oil was used as fuel for this engine. Since 1892, when the late Rudolph Diesel invented this type of prime-mover, its use has spread to power-plants both on land and sea with success. There are now many manufacturers of Diesel engines, each claiming certain advantages for its particular patented improvements. In the United States there are eight works producing them. Their operation is becoming better understood, and when their low fuel consumption, labor, small area, and output are considered, the engine is without doubt highly efficient. Numerous papers have been prepared on the subject of the Diesel, but this is probably the first time that a practical treatise has been prepared of value to all grades of engineers. All existing literature has been studied and drawn upon, including leading engineering journals, and several well-known makers were consulted. The work is copiously illustrated, the author being able to secure drawings, photographs, and sectional views of nearly all the principal Diesel engines made. Indicator-cards from actual operation are given. The book is really worth while and students and engineers will find it easy to understand the details of construction, operation, and correction, and various types given.

Industrial Progress

COOLING-PONDS FOR MECHANICAL PLANTS

Where the available water for a steam-plant is polluted or heavily mineralized, it is usually advisable to condense the exhaust steam and use it over and over again. This is also done where water is expensive, both for boiler-feed for steam-engines and for cooling-water for internal-combustion engines. This procedure requires the installation of a system for cooling the water. The simplest way is to construct a pond with partitions arranged so that the water is obliged to travel through the entire pond before being used over again. Unless a large area is used for such a pond the reduction in temperature is small and it is usually necessary to use additional means to cool the water. The Spray Engineering Co., of Boston, has perfected spray-cooling systems for this purpose. The water is led to a series of nozzles which discharge it in a fine spray over the surface of the pond. Where necessary the water may be sprayed and cooled a number of times before being used again. The illustration shows a cooling-pond and spray system in use at the plant of the Copper Queen Mining Co., at Douglas, Arizona. Tests made on an ordinary cooling-pond have shown that the amount of heat dissipated is 3.5 B.t.u. per sq. ft. per degree Fahrenheit difference, while that dissipated by a cooling-pond equipped with a spray system was 127 B.t.u. per sq. ft. per degree Fahrenheit difference. Other tests have shown a reduction in temperature of the water after spraying of from 10 to 20°, depending upon the temperature of the air and the humidity.



COOLING POND FOR COPPER QUEEN MINING COMPANY.

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Construction News Summary

STREETS AND ROADS

Bakersfield, Cal.—Contract for improvement of one mile of Brundage lane was awarded to Federal Construction Co. at $0.0889 for oil wearing surface on concrete base.——Contract for construction of section 1-A of Bakersfield-McKittrick road has been awarded to Brashear-Burns Co., Van Nuys Bdg., Los Angeles, for $27,914.

Glendale, Cal.—Contract for improvement of Brand boulevard has been awarded to George H. Oswald, 405 O. T. Johnson Bdg., Los Angeles, at 13c. for grading and asphalt paving, 14c. for concrete gutters, 24c. for curbs, and 9c. for sidewalks; a total of $25,988.34.

Huntington Beach, Cal.—Contract for improving several streets has been awarded to George H. Oswald, 405 O. T. Johnson Bdg., Los Angeles, at 1c. for grading, 11c. for concrete paving, and 20c. for curbs; a total of $81,481.

Los Angeles, Cal.—Contract for improving Dexter street has been awarded to Calvin McCray, 5263 Aldama street, at the following unit prices: grading, 1½c.; cultivating, tamping, and oiling, 1⅜c.; curbs, 30c.; sidewalks, 10½c.; concrete gutters, 14c.; a total of $1242.37. Other bidders were: H. C. Withers, $1258.32; E. Schelling, $1302.60; R. A. Merrill, $1334.10; Peter L. Ferry, $1580.25.——Contract for improving Effie street has been awarded to H. C. Withers at the following prices: grading, 6½c.; asphalt pavement, 13c.; concrete pavement, 16c. for 6-in. and 14c. for 5-in.; curbs, 30c.; sidewalks, 10c.; a total of $2411.07. Other bidders were: Fairchild-Gilmore-Wilton Co., $2683.02, and Wattson & Spicer, $2725.55.—Wattson & Spicer, Wright & Callender Bdg., were low bidders at 24c. per cu. yd. for excavation of 8800 cu. yd. material at Fort McArthur.——Contract for improving Wilton place has been awarded to Clark & Henery Construction Co., Stockton, for $27,435.71.——Contract for grading and construction of asphalt pavement, curbs, sidewalks, and gutters on Dayton avenue has been awarded to Ford & Stout, Bradbury Bdg., $43,178.97.——Board of Supervisors has decided to extend Pico boulevard so as to give direct highway to Santa Monica. Paving of 3½ miles of highway will be required.

Manhattan Beach, Cal.—Contract for construction of concrete pavement and sidewalks on several streets has been awarded to Municipal Improvement Co., Richmond, for $11,594.03. Other bidders were: Modern Construction Co., $12,027.99; California-Arizona Construction Co., $12,319; F. L. Vicente, $12,556.63; Charles Salata, $12,886.13.

Oakland, Cal.—Contract for improvement of 27th avenue has been awarded to Hutchinson Co., 13th and Franklin streets, at the following unit prices: excavation, 40c. per cu. yd.; redwood curbs, 10c. per lin. ft.; concrete gutters, 14c. per lin. ft.; oil macadam pavement, 9½c. per sq. ft.; cement sidewalks, 10c. per sq. ft.; 8 by 29-in. corrugated iron and concrete culverts, $2 per lin. ft.; and 8 by 24-in. culverts, $2 per lineal foot.

Ontario, Cal.—Contract for improving A street, Bon View avenue, and East Euclid avenue, has been awarded to James L. Frazier, Long Beach, at 8⅜c. per sq. ft. for paving, and 1c. for grading on East Euclid avenue and 2c. on the other work. Total cost of the work is $44,516.07.

Redwood City, Cal.—County surveyor James Neumann is preparing plans for highway along east side of Southern Pacific railroad tracks from San Bruno to Palo Alto, parallel to State highway.

Sacramento, Cal.—Fred Hoffman, Long Beach, was low bidder for construction of State highway in Imperial county from El Centro to Dixieland at the following unit prices: excavation without classification, 38c. per cu. yd.; 18-in. corrugated iron pipe, 50c. per lin. ft.; 24-in. pipe, 75c.; 36-in. pipe, $2; class B concrete in culverts and monuments, $15 per cu. yd.; class B concrete in pavement, $4.45 per cu. yd.; guard-rail, 75c. per lin. ft.; monuments, $2 each; a total of $72,089. Engineers' estimate was $100,408. State will furnish pipe railing for culverts, reinforcing steel, corrugated metal pipe, and cement; value, $43,891.86.——Contract for construction of ten miles of State highway in Mariposa county, between easterly boundary and Cathay-White Rock road has been awarded to G. R. Daley, 440 McNeece Bdg., San Diego.——Contract for construction of 4.2 miles of State highway in Sonoma county between Reclamation and Fairville has been awarded to Bates, Borland & Ayer, Oakland Bank of Savings Bdg., Oakland.

San Diego, Cal.—Contract for improving Brooks avenue has been awarded to Jonas Hanson, 2135 Kearney street, at the following prices: excavation, 36c. per cu. yd.; embankment, 5c. per cu. yd.; sidewalks, 11c. per sq. ft.; and curbs, 34c. per lineal foot.

San Francisco, Cal.—Contract for re-grading Chestnut street between Larkin and Franklin has been awarded to F. Rolandi for $30,000.

San Mateo, Cal.—Contract for construction of pavement, curbs, and gutters on several streets has been awarded to Federal Construction Co., Sharon Bdg., San Francisco, at 50c. per cu. yd. for grading, 13c. per sq. ft. for pavement, 35c. per lin. ft. for curbs, 15c. per lin. ft. for gutters, 50c. per lin. ft. for 4-in. sewer, and $1.50 each for 4-in. wyes, a total of $8432.

Santa Ana, Cal.—Contract for construction of 4-in. concrete pavement 16 ft. wide for five miles on Placentia-Yorba Linda road has been awarded to Max L. Hubermann at the following unit prices: excavation, 24c.; shaping roadbed, 5c.; concrete in structures, $8.50; concrete in pavement, $1.45; reinforcing steel, 4c.; a total of $16,458.70. Engineer's estimate was $20,790.64.

Santa Monica, Cal.—Contract for grading, paving, and construction of curbs, sidewalks, culverts, and storm-drains on Central avenue has been awarded to National Paving Co., Kansas City, Missouri (represented by G. S. Bowdish, Rosslyn Hotel, Los Angeles), for $50,810.05.

Portland, Oregon.—Contract for construction of bitulithic pavement on East 28th and other streets has been awarded to Oregon Hassam Paving Co., Board of Trade Bdg., for $41,366.——Oregon Independent Paving Co., 294 East Salmon street, has been awarded contract for construction of bitulithic pavement on Union avenue for $29,950.——Oscar Huber, Sherlock Bdg., was low bidder at $1.25 per sq. yd. for construction of bitulithic pavement on Ainsworth avenue. The prevailing price for this type of pavement has been from $1.40 to $1.85 per square yard.——Following bids have been received for basalt block paving on East Stark street: Warren Construction Co., $3.86 per sq. yd.; John Keating, $3.14; Montague-O'Reilly Co., $2.95; Vancouver Construction Co., $3.05.

Salem, Oregon.—State Highway Commission has decided upon the expenditure of the following amounts in 1916: For administration, including bridges, $25,000. In Clatsop county, $20,500, including $9000 for surfacing Columbia River highway. In Columbia county, $36,000, including $22,000 on improvement of Ranier hill. In Hood River and Wasco counties, $45,000, contingent upon Wasco county voting bonds for construction of highway between Hood River and Mosier. In Crook county, $10,000. In Washington county, $11,500. In Douglas and Josephine counties, $25,000, principally for elimination of heavy grade on divide between the two counties. In Lane county, $5000, conditional upon county raising a like amount. In Jackson county, $40,000 in Siskiyou mountains. In Polk county, $5000, conditional upon county raising a like amount. In Tillamook county, $45,000, conditional upon county raising a like amount. In Yamhill county, $4500, conditional upon county raising a like amount. Total appropriation, $237,000.

Olympia, Wash.—Contract for graveling 12 miles of Sunset highway from Wenatchee northerly has been awarded to S. G. Kinder, Bridgeport, for $1.42 per cu. yd., or a total of $7568.60.——Contract for grading Inland Empire highway for 8¾ miles from Pullman south has been awarded to G. L. Stickler, Davenport, for $23,887.——Contract for grading 11½ miles of Inland Empire highway from Kiona to Richland has been awarded to H. L. Wilson Co., Walla Walla, for $16,945.85.——Contract for grading 9½ miles of Inland Empire highway from Touchet to Wallula has been awarded to G. L. Stickler, Davenport, for $22,639.——Contract for grading 9 miles of Inland Empire highway from Rosalia to Oakesdale has been awarded to General Construction Co., Spokane, for $21,646.45.——All contracts were awarded to lowest bidder on basis of unit prices.

RAILROADS

San Francisco, Cal.—Contract for construction of railroad from Rosasco to Hetch-Hetchy valley has been awarded to F. Rolandi, 550 Montgomery street, for $1,543,080.74.——Contract for the construction of a section of the Church Street Municipal Railway, between 18th and 22nd streets, has been awarded to the Contra Costa Construction Co. for $120,500.

Medford, Oregon.—S. S. Bullis, owner of Southern Oregon Traction Co., has announced that construction of extension of electric railroad to Ruch and the Blue Ledge copper mine, about 30 miles, will be started about January 1.

Portland, Oregon.—Contract for re-lining 5435 ft. of tunnel under Columbia Park for Oregon-Washington Railroad & Navigation Co. has been awarded to Guthrie-McDougall Co., Pittock Block, for $400,000.

Bellingham, Wash.—Contract for construction of Bellingham, Mt. Baker & Spokane railroad has been awarded to Marsh,

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Hutton & Power Construction Co., New Westminster, B. C., who will be ready to let sub-contracts about January 1. Road will be 288 miles long. Ducane, Dutcher & Co., Vancouver, B. C., are consulting engineers.

SEWERS AND DRAINAGE

Richvale, Cal.—Richvale drainage district has been formed. Bert Evans, C. B. Harris, and J. G. Rystrom are directors.

San Diego, Cal.—Doran & Armstrong, who were recently awarded contract for completion of Ocean Beach sewer, have refused to sign contract on advice of their attorney, who states that the assessment roll may be illegal.

San Francisco, Cal.—Tibbits Pacific Co., 16 California street, was awarded contract at $35,900 for construction of sewers in South Bay View district.

Bonners Ferry, Idaho.—Contract for construction of sewer system has been awarded to Hurd, DeCamp & Woods, Spokane, for $24,778.——Contract for construction of sewage-disposal plant has been awarded to Clifton Applegate Co., Spokane, Wash., for $23,493.

Weiser, Idaho.—Contract for construction of drainage system for East Weiser irrigation district has been awarded to Phelps Construction Co. for $16,000.

Corinne, Utah.—Contract for construction of drainage system in this vicinity has been awarded to J. P. O'Neill Construction Co., Ogden. Concrete pipe for the drains will be furnished by Corinne Concrete Tile Co., Brigham City. Total cost of work is estimated at $160,000.

Salt Lake City, Utah.—Tintic Tunnel Co. has been incorporated for $2,000,000 to construct five-mile tunnel for drainage of mines in Tintic district. Double-track electric railway will be constructed in tunnel. F. C. Richmond, D. R. Beebe, S. B. Smith, and B. D. Lyon are directors.

Seattle, Wash.—Contract for construction of sewers on 6th avenue and other streets has been awarded to Washington Paving Co., Smith Bdg., for $78,694.30.

Tacoma, Wash.—Contract for dredging waterway to proposed building of Glacier Fish Co. has been awarded by Oregon-Washington Railroad & Navigation Co. to Tacoma Dredging Co., National Bank of Tacoma Bdg., for $125,000. Depth of 27 ft. at low water for distance of 1500 ft. will be provided.

BRIDGES

Hanford, Cal.—S. G. Smartt, Bakersfield, has been awarded contract for construction of bridges and culverts on county highway near city at $7.19 per cu. yd. for concrete and ½c. per lb. for placing steel, a total of $6020.23. County furnishes all materials.

Sacramento, Cal.—Contract for construction of reinforced concrete bridge on state highway over Myers creek in Imperial county has been awarded to Holland Construction Co., San Diego.——Contract for construction of bascule bridge in Yolo county has been awarded to Security Construction Co., 37th and Alameda streets, Los Angeles, for $24,671, by State Highway Commission.

WATER SUPPLY AND IRRIGATION

Colusa, Cal.—Corporation has been formed and $60,000 in stock subscribed for Cheney Slough irrigation project. Construction of system, which includes pumping plant, concrete intake, and distributing-canals, will be started at once. Charles de St. Maurice is engineer.

Merced, Cal.—Crocker-Huffman Land & Water Co. will spend $40,000 on improvement of domestic water-system.

Oakdale, Cal.—Oakdale irrigation district will make extensions to system costing $100,000.

Tracy, Cal.—Walter G. Hunter, Stockton Savings & Loan Society Bdg., Stockton, is preparing plans for irrigation system for West Side irrigation district. Estimated cost is $285,000. Water is to be pumped from San Joaquin river and distributed by gravity canals. C. E. Grunsky, Mechanics Institute Bdg., San Francisco, is consulting engineer.

Billings, Mont.—Big Horn Canyon Irrigation & Power Co. project has been approved by U. S. Reclamation Service. Project includes construction of 400-ft. dam at mouth of Big Horn canyon, southwest of Hardin, irrigation of 100,000 acres of land and development of 200,000 horse-power.

Milwaukie, Oregon.—Contract for construction of distribution system for municipal waterworks has been awarded to Giebisch & Joplin, Rothschild Bdg., Portland, for $22,542.40.

Portland, Oregon.—Irrigation of 100,000 acres of land east of Deschutes river in Crook and Jefferson counties is proposed. Estimated cost of construction is $55 per acre. Paul C. Bates, 493 Hassalo street, is interested.

Salem, Oregon.—State engineer John H. Lewis, acting in conjunction with the U. S. Reclamation Service, has reported that 15,500 acres of land on the Ochoco project near Prineville can be irrigated for $51.30 per acre. It has also been announced that the cost of construction of the Silver Lake project, including about 50,000 acres, would be $25 per acre.

Salt Lake City, Utah.—Contract for construction of first unit of dam in Parley's canyon for municipal water-supply has been awarded to Parrott Bros. for $75,298.90.

North Yakima, Wash.—Harrington-Peters Co., Oriental Bdg., Seattle, was awarded contract at $129,000 for completion of Lake Keechelus reservoir for U .S. Reclamation Service. Work will be commenced in spring.

BUILDING CONSTRUCTION

Avon, Cal.—Associated Oil Co. will spend $500,000 for enlarging refinery.

Berkeley, Cal.—Contract for furnishing structural steel for addition to University library has been awarded to Pacific Rolling Mills Co., Sharon Bdg., for $46,232.——Contract for granite work on Benjamin Ide Wheeler hall has been awarded to Raymond Granite Co., Division and Potrero avenue for $225,000.

Crockett, Cal.—Contract for construction of wharf and buildings for American-Hawaiian Sugar Co. has been awarded to Clinton Construction Co., 704 Market street, San Francisco, for $106,000.

Fresno, Cal.—Construction of buildings for State Normal school will be completed by State under supervision of state engineer W. F. McClure, Forum Bdg., Sacramento.

Los Angeles, Cal.—Contract for construction of building for Security National Bank has been awarded to F. O. Engstrum Co., 5th and Seaton streets. Structural steel will be furnished by Baker Iron Works, 986 North Broadway. Estimated cost of building is $300,000.——Contract for construction of eight-story reinforced concrete office building for W. G. Kerckhoff has been awarded to Weymouth Crowell, 2026 West 9th street, for $165,000.——Contract for construction of buildings for Jefferson high-school building has been awarded to J. F. Atkinson, W. P. Story Bdg., for $182,028.

Sacramento, Cal.—Contract for construction of hall of justice has been awarded to Howard S. Williams, Hearst Bdg., San Francisco, for $197,426. Contract for furnishing steel work for city jail portion has been awarded to Ralston Iron Works, 20th and Indiana streets, San Francisco, for $18,624. Arrangements have been made to transfer money from other funds so that the amount available will be sufficient.——State Supreme Court has rendered decision upholding legality of bond issue for purchase of site for State buildings. Estimated cost, $3,000,000. Bonds were voted in November, 1914.

Grants Pass, Oregon.—Factory for Utah-Oregon Sugar Co. will be built here instead of at Medford, as originally intended. Estimated cost is $500,000.

Oregon City, Oregon.—Hawley Pulp & Paper Co. will construct addition to plant costing $500,000.

Portland, Oregon.—Plans for post-office have been completed and forwarded to Supervising Architect, Treasury Department, Washington, D. C. Bids will probably be taken in February. Estimated cost is $1,000,000.——Plans for auditorium building costing $600,000 have been completed by J. H. Freedlander of New York and bids will soon be advertised. Whitehouse & Fouilhoux, Wilcox Bdg., are local architects.

Salt Lake City, Utah.—Utah-Idaho Sugar Co. will erect sugar refinery in Bear River valley costing $600,000.

Seattle, Wash.—Plans have been completed and call for bids will soon be made for construction of 12-story building for Arctic Club. Estimated cost is $400,000. A. Warren Gould, American Bank Bdg., is architect.——Bonds for $750,000 for construction of school buildings have been voted.

LIGHT, HEAT, AND POWER

Keeler, Cal.—Contract for construction of power transmission line to Cerro Gordo mines, about seven miles, has been awarded to M. A. Stampher & Co., 1821 South Hoover street, Los Angeles.

San Francisco, Cal.—Proposed expenditures by Great Western Power Co., 14 Sansome street, include $150,000 for motor-generator sets for Key Route system in Oakland, transmission line 150 miles long from Las Plumas to Oakland, sixth unit for power-plant at Las Plumas, $500,000, cable under San Francisco bay, $500,000, sub-station and transmission lines in San Francisco, $842,000, and other transmission lines, $1,040,000.

MISCELLANEOUS

San Francisco, Cal.—Union Iron Works has been awarded contract for construction of steamer of 10,000-ton capacity for F. D. M. Strachan.——Contract for construction of 75,000-bbl. tank-steamer for Vacuum Oil Co. has been awarded to Union Iron Works.——Subject to prior removal, bids will be received until 11 a.m., January 20, at U. S. Engineer Office, 401 Custom House, for removal of wreck of steamer 'City of Panama,' now lying in San Francisco bay and declared a menace to navigation.——Contract for construction of first section of beach esplanade has been awarded to J. D. Hannah, Monadnock Bdg., for $89.50 per lin ft. and $6 per cu. yd. for rubble wall.——Con-

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tract for construction of three tank steamers, two for Standard Oil Co. and one for Elkstrom & Co., of London, has been awarded to Union Iron Works. They will cost $950,000 each.——Contract for construction of 10,000-ton steamer for Rolph Navigation Co. has been awarded to Union Iron Works for $1,000,000.

Engineering Societies and Conventions

IDAHO SOCIETY OF ENGINEERS. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Ford W. Harris, secretary, 1029 Higgins building.

Los Angeles Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Edward Woodbury, secretary, 255 East 3rd street.

OREGON SOCIETY OF ENGINEERS. Orrin E. Stanley, secretary, room 409, City Hall, Portland.

Portland Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. Charles McGonigle, president, care Western Sheet Metal Works.

Portland Section, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Paul Lebenbaum, secretary, 45 Union Depot.

San Francisco Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. E. T. Thurston, Jr., secretary, Mechanics Institute building.

San Francisco Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. F. W. Gay, secretary, care J. G. White & Co., Alaska Commercial building.

San Francisco Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. A. G. Jones, secretary, 811 Rialto building.

Southern California Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. W. K. Barnard, secretary, 701 Central building, Los Angeles.

Coming Conventions

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS. Winter meeting, Baltimore, Maryland, January 12-15, 1916. J. C. Olsen, secretary, Cooper Union, New York.

MONTANA INSTITUTE OF MUNICIPAL ENGINEERS. Annual meeting, Billings, Montana, January 17-19. Carl C. Widener, secretary, Bozeman.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Annual meeting, New York, January 19-20. Charles Warren Hunt, secretary, 220 West 57th street, New York.

NATIONAL DRAINAGE CONGRESS. Annual meeting, Cairo, Illinois, January 19-21. Edmund T. Perkins, vice-president, First National Bank Bdg., Chicago.

NATIONAL LIME MANUFACTURERS' ASSOCIATION. Annual meeting, Cleveland, Ohio, first week in February, 1916.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING. Chicago, Illinois, February 15-18. J. P. Beck, secretary, 208 South La Salle street, Chicago, Illinois.

AMERICAN ROAD BUILDERS' ASSOCIATION. Annual Convention, Pittsburg, Pennsylvania, February 28 to March 3. E. L. Powers, secretary, 150 Nassau street, New York.

Obituary

JAMES MAPES DODGE, chairman of the board of the Link-Belt Company, died at his home in Philadelphia, December 4.

PARKER BARRETT, pioneer oil-man of Kern county, California, and one of the original owners of the first Lakeview gusher, died at his home in Bakersfield, California, December 18.

ALEXANDER W. SWANITZ, who was engineer in charge of the construction of the Alaska Central railroad died December 21 at his home in Alameda, California.

Personal

W. V. BUCKNER has been appointed road overseer for Kings county, California.

FRANK S. ROBINSON, of Chico, California, has been appointed engineer for the Richvale drainage district.

S. B. BAGNALL, of Oxnard, California, has been appointed secretary of the Ventura County highway commission.

R. D. INMAN has been elected a member of the Port of Portland commission, succeeding S. M. MEARS, who resigned.

ERLE M. DOWNING has been appointed secretary of the Anderson-Cottonwood irrigation district in Shasta county, California.

C. R. SUMNER has been appointed city engineer of Hermosa Beach, California, succeeding former city engineer ATCHLEY, who resigned.

GELASIO CAETANI, now an officer in the Italian engineering corps, has been wounded in action and recommended for the military medal.

L. A. POCKMAN has been appointed safety engineer of construction for the department of safety of the Los Angeles Industrial Accident Commission.

T. W. RANSOM, consulting mechanical engineer for the board of public works of San Francisco, has resigned to engage in private practice in San Francisco.

F. C. ROBERTS, of Berkeley, California, has been appointed general inspector for the architectural division of the California state engineering department.

S. G. BENNETT, formerly city engineer of Oxnard, California, has resigned to take the position of field engineer for the Ventura County highway commission.

SLEDGE TATUM has been appointed acting chief geographer for the United States Geological Survey. He will continue to serve as geographer in charge of the Rocky Mountain division.

Major R. R. RAYMOND, who has been in charge of harbor work and fortifications at San Pedro and San Diego has been transferred to Honolulu to take charge of construction of fortifications.

At the annual meeting of the San Francisco Association of members of the American Society of Civil Engineers, H. L. HAEHL was elected president and JEROME NEWMAN, vice-president.

MARK DANIELS, superintendent of national parks, has resigned to devote himself to private practice as landscape engineer. He will be succeeded by R. B. MARSHALL, formerly chief geographer for the United States Geological Survey.

WILLIAM H. STEARNS, assistant chief engineer for the Riverside county, California, highway commission, has resigned to take a similar position with the Ventura County highway commission, and to assist in the organization of the work of that commission.

The American Association of State Highway Officials has elected the following officers for the coming year: president, HENRY G. SHIRLEY, Baltimore; vice-president, AUSTIN B. FLETCHER, Sacramento, California; secretary, JOSEPH HYDE PRATT, Chapel Hill, North Carolina; and treasurer, F. F. ROGERS, Lansing, Michigan.

R. B. MILLER, formerly traffic manager for the Oregon-Washington Railway and Navigation Co. has resigned to take a position with Twohy Bros., railroad contractors of Portland and San Francisco. It is understood that he will be connected with the California & Oregon Coast railroad, now being constructed from Grant's Pass toward Crescent City, California.

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